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THE RR LYRAE STARS IN MESSIER 3

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by

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INTRODUCTION AND SUMMARY

In 1937 Dr. Detre has started a study of the period-changes of variables in globular clusters. In course of this programme several hundred plates have been taken of the clusters M3, M5, M15, M56 and M92 with the 24-inch Newtonian telescope of the Konkoly Observatory by Dr. Julia Balázs, Dr. Detre, Dr. Kulin, M. Lovas, Dr. Ozsváth and the writer. This work is a survey of all the measurable RR Lyrae stars in the globular cluster M3.

A number of investigations have been already published dealing with the secular period changes of RR Lyrae stars in different clusters (M3: Martin 1942, Belserene 1952; M4: Wilkens 1964; M5: Oosterhoff 1941; M15: Izsák 1956, Mannino 1956, Grubissich 1956, Nobili 1957, Notni and Oleak 1958, Bronkalla 1960, Fritze 1962; M53: Wachmann 1964; ω Cen: Martin 1938, Belserene 1964 and in the general field: Detre 1955). The authors have generally treated the variables as if their periods vary linearly with time.

It was a great help for me that a considerable part of the plate material obtained for M3 at Budapest up to the year 1956 has been already discussed by Dr. Ozsváth. He has constructed mean light curves and O—C diagrams for about 60 variables. On the Colloquium on Variable stars held in summer 1956 at Budapest he has given a condensed account of his results (Ozsváth, 1957). In the years 1958—1963 the author has taken further plates, measured them and rediscussed the whole material consisting of 214 plates obtained at Budapest and 17 plates supplied by the Hamburg Observatory (Table 1). On the majority of the plates 117 RR Lyrae stars were measurable (Table 8). The standard errors of the measurements are given in Table 2. Normal points have been formed for constructing the light curves for 111 variables (Table 7, Figures 15—27). Table 3 contains the data for 113 variables.

The crowding effect distorting the photometric measures inside 2′.5 of the centre has been fully considered (Fig. 1). O—C diagrams could be constructed for 112 variables (Figures 28—64) using the whole material available, beginning with Bailey's observations. With the exception of 7 variables all the others show period changes. A quadratic form suggesting a period change according to the simple relation: $P = P_0 + \beta t$, fits the O—C diagrams for 47 variables, indicating period lengthening in 22, period shortening in 25 cases. For the mean value of the coefficient in the quadratic term of the O—C values I get

$$10^{10}\,\beta = -0.63 \pm 1.05.$$

The dependence of β on the period is shown in Figure 4, their frequency-distribution in Figure 3 compared with that of the variables in M5 and in ω Centauri.

It is a general rule that variables having complicated O—C diagrams exhibit strong light curve changes. The O—C diagrams of RRc stars and irregular RRab stars consist of cycles of different length and amplitude (Fig. 5 and 6).

In the period-amplitude relation for regular stars lying more than 2'.5 outside of the centre (Fig. 7) the separation of the RRab stars into a short- and long-period sequence (Belserene 1954) is clearly shown. The same separation is apparent for different parameters of the light curve (Fig. 8: m^{max} versus period; Fig. 9: $\overline{B-V}$ versus period; Fig. 10: $\varepsilon = M - m$ versus period). RRab stars of the long period sequence show the same characteristics as stars of the short period sequence having periods shorter by 0^d1.

Of the 112 variables investigated so far, 36 (32%) show well pronounced light curve changes. The frequency distribution of the periods for these irregular stars is given in Table 5 and represented also in Fig. 13. They have the highest relative abundance in the period interval 0^d47-0^d56. In the period-amplitude relation their greatest amplitudes fit the relation valid for regular RR Lyrae stars (Fig. 12). This has been already noted by Preston (1964, p. 43) who writes: "Curiously the period versus amplitude relation for simply periodic variables appears to be the upper envelope of the amplitude variations for multiply periodic variables. This suggests that multiple periodicity is associated with a mechanism that acts to suppress the normal pulsation properties of the variables." Their characteristics show no correlation with distance from the centre.

The RRab stars in ω Cen and M5 exhibit the same separation into two sequences like in M3 (Belserene 1954). In these three clusters a strong correlation seems to hold between the number of stars on the long period RRab-sequence and on the RRc-sequence respectively (see Table 6). The two branches of RRab stars occupy the same place in the period-amplitude relation for all the three clusters, the short-period branch being considerably steeper. The β values are quite different on the two branches (Table 7). In M3, M5 and ω Cen we have 48 easily measurable variables on the short-period sequence having parabolic O—C diagrams with

$$10^{10}\,\beta = +0.01 \pm 1.10$$

and 36 variables on the long-period sequence, with

$$10^{10}\,\beta = +4.78 \pm 1.98.$$

The long-period sequence shows a strong tendency for period lengthening.

The amplitude versus period relation for field RR Lyrae stars with different spectral index, ΔS (Preston 1959), suggests (Fig. 7) that the long-period RRab sequence in globular clusters contains RR Lyrae stars of low metal content, while stars of the short-period sequence have a higher metal/H value. The two distinct RRab-groups are probably the continuations of the two sequences of red stars on the horizontal branch in the HRD (Arp, 1955). They may represent stars advancing in opposite directions along the horizontal branch in course of their evolution (Woolf 1964).

The author is indebted to Dr. L. Detre, Director of the Konkoly Observatory, for suggesting the investigation and for many valuable discussions; to Dr. I. Ozsváth, for handing over his material and for sending the plates taken by him at the Hamburg Observatory; to Dr. Julia Balázs-Detre for following with attention this work and for many helpful remarks; to Mrs. K. Barlai and M. Lovas for aid in preparing the manuscript.

MATERIAL

M3 (NGC 5272) is the globular cluster richest in variables. Its equatorial and galactic coordinates are:

$$\alpha = 13^h\,39^m\!.9 \qquad (1950) \qquad l^{II} = 42^\circ$$

$$\delta = +28^\circ\,38' \qquad\qquad\qquad b^{II} = +79^\circ$$

The first systematic investigation of the variables in the cluster was made by S. I. Bailey (B; 1913), and most of the variables were discovered by him. Between 1895 and 1900 (J. D.2413664—14842) the plates were taken partly at Arequipa with the 24″ Bruce Telescope using exposures of 30 to 75 minutes partly with the 13″ Boyden refractor (J. D. 241 3372—14807; exposures 70 to 183 minutes) and the 36″ Crossley Reflector at Mt. Hamilton (J. D. 2415160—15161; exposures 10 minutes with one exception of 60 minutes). The Lick plates are of the best quality. The plates of long exposure provide only inaccurate epochs. Bailey gives the brightness data for 132 variables from 90 plates.

In 1912 and 1915 (J. D. 2419479—19534 and J. D. 2420625—20656) 36 plates were taken with the 60″ telescope of Mt. Wilson Observatory with exposures 2 to 20 minutes. For 11 pairs of the plates the mean value was considered. In this way the exposure time may amount to 40 minutes. The time interval between two exposures may be also considerable. Finally J. H. Hett (H) gives brightness values for 48 variables at 25 moments (1942).

In 1920 (J. D. 2422455) one and in 1921 (J. D. 2422729—22840) 135 plates were taken with the 1 meter telescope of the Hamburg-Bergedorf Observatory. The exposure times were 20 and 10—13 minutes respectively. J. Larink (L) measured not more than 129 variables per plate (1922).

1 + 91 plates were taken in 1924 (J. D. 2423858) and in 1925 (J. D. 2424283—24317) respectively, with the 1.22 m reflector of the Babelsberg Observatory, 16 plates with one hour and the others with 15 minutes exposure time. Th. Müller (M) published observations for 159 variables (1933).

In 1926 (J. D. 2424564—24642) J. Schilt took a series of 97 plates with 8 minutes exposure time utilizing the 60″ Mt. Wilson reflector for a study of RV CVn. P. Slavenas (S) could measure only 47 variables because the cluster was on the edge of the plates (1929).

In the same year (J. D. 2424647—24684) further 75 plates were taken with the 60″ Mt. Wilson reflector by J. L. Greenstein (G) with the same exposure time. He published magnitudes for 117 variables using these plates (1935). In 1938 (J. D. 2428964—28983) 4 pairs of plates were taken with the 61″

reflector of the Oak Ridge Station with 8—10 minutes exposure time. M. Schwarzschild (Sch) has taken the mean values of magnitudes for these pairs of plates (1940).

In 1939 (J. D. 2429367—29431) 44 plates with 9—15 minutes exposure length were taken at the Perkins Observatory with the telescope diaphragmed to 60″. J. H. Hett published observations for 48 variables (1942).

In 1940 (J. D. 2429670—29834) 106 double photographs of 30—40 minutes exposure time were obtained with the Rockefeller double astrograph at Johannesbourg. W. Chr. Martin (Ma) measured the magnitudes for 132 variables but published epochs only for 121 of them (1942).

In the years 1946 (J. D. 2431965—31995) and 1948 (J. D. 2432682—32700) 28 and 10 photographs were taken, respectively, with the 60″ Mt. Wilson reflector. The exposure time was 5—7 minutes. E. P. Belserene published magnitudes for 52 easily measurable variable stars (1952).

In 1953 (J. D. 2434447—34508) 25 plates were taken with the 100″ Mt. Wilson reflector diaphragmed to 58″. The exposure time was 15 minutes in the average. M. Roberts and A. Sandage (RS) published magnitudes for 78 variables (1955).

Between 1949 and 1960, 177 plates were obtained with the 40/40 cm Schmidt-telescope at Burakan (J. D. 2435577—35615) and with the 40 cm GAIS astrograph (J. D. 2433034—37130), respectively. On these plates a great number of variables were estimated. B. V. Kukarkin and N. P. Kukarkina (K) published their observations on 3 variables, (1961 b).

In Budapest (Bp) 214 plates were taken from 1938 till 1962 (J. D. 2428963—37791) using the 24″ reflector of the Konkoly Observatory (f = 3600 mm, 1 mm equals 57.″3 on the plates). Kodak Eastman 40, Agfa Astro Spezial and Kodak 103 aO plates were used with exposures 10 to 17 minutes. In 1957 (J. D. 2435920; 35933) 17 further photographs were obtained by I. Ozsváth in Hamburg on Kodak OaO plates with 12—16 minutes exposure time. Generally 117 variables of RR Lyrae type were measurable on the majority of these 231 plates. The limiting magnitude of the plates is about $17^{m}0$. A detailed enumeration of the plates obtained in Budapest and in Hamburg is given in Table 1. Plates of high quality are marked by the number 5; those of mediocre quality by 3, plates of inferior quality by 1.

Generally the observational material covers the time interval of observations rather evenly, however, it is rather incomplete in the case of several variables exhibiting strong variations in their light curve and in their period. Unfortunately even these interesting variables deserving the greatest attention have been often neglected by several authors. It would be of great value to measure all the variables on all the plates available.

Since 1950 the observational material can be considered as continuous.

Table 1

LIST OF PLATES

Plate	J. D. 2 400 000 +	Exp. time in minutes	Kind of plate	Quality of plate	Observer
R 1681	28 963.487	15	Guilleminot Superfulgur	5	Kulin
R 1717	28 991.403	15	,,	4	,,
R 1718	.416	15	,,	4	,,
R 1719	.430	15	,,	5	,,
R 1723	.522	15	,,	5	,,
R 1724	.542	15	,,	5	,,
R 2133	29 346.376	15	,,	3	,,
R 2134	.392	15	,,	3	,,
R 2368	29 719.549	12	,,	4	,,
R 2369	.560	12	,,	3	,,
R 2376	29 720.546	12	,,	4	,,
R 2377	.558	12	,,	4	,,
R 2413	29 774.405	12	,,	3	,,
R 2414	.417	12	,,	2	,,
R 2416	29 775.403	12	,,	4	,,
R 2417	.415	12	,,	4	,,
R 2418	.426	12	,,	2	,,
R 2419	.437	12	,,	3	,,
R 2420	.447	12	,,	2	,,
R 2612	30 052.462	12	,,	3	,,
R 2613	.474	12	,,	3	,,
R 2614	.489	12	,,	3	,,
R 2615	.501	12	,,	3	,,
R 2622	30 078.418	12	,,	4	,,
R 2623	.434	12	,,	4	,,
R 2624	.470	12	,,	4	,,
R 2625	.483	12	,,	4	,,
R 2626	.498	12	,,	4	,,
R 2627	.509	12	,,	3	,,
R 2628	.521	12	,,	4	,,
R 2629	.536	12	,,	3	,,
R 2630	.548	12	,,	4	,,
R 3163	33 390.497	10	Eastman 40	3	Balázs, Detre
R 3164	.534	10	,,	4	,,
R 3165	.545	10	,,	4	,,
R 3166	.558	10	,,	3	,,
R 3167	.570	10	,,	3	,,
R 3168	.586	11	,,	4	,,
R 3173	33 420.424	10	,,	4	,,
R 3174	.438	10	,,	4	,,
R 3175	.450	10	,,	4	,,
R 3176	.476	10	,,	4	,,
R 3177	.487	10	,,	4	,,
R 3178	.498	10	,,	4	,,
R 3179	.510	11	,,	3	,,
R 3180	.523	13	,,	2	,,
R 3181	33 421.385	10	,,	4	,,
R 3182	.442	10	,,	4	,,
R 3183	.454	10	,,	3	,,
R 3184	.465	10	,,	3	,,
R 3185	.475	10	,,	2	,,
R 3186	.486	10	,,	3	,,
R 3187	.497	10	,,	3	,,

Table 1 (continued)

Plate	J. D. 2 400 000 +	Exp. time in minutes	Kind of plate	Quality of plate	Observer
R 3188	33 421.535	10	Eastman 40	2	Balázs, Detre
R 3189	.548	10	,,	3	,,
R 3190	33 422.398	10	,,	4	,,
R 3191	.431	10	,,	4	,,
R 3192	.442	10	,,	4	,,
R 3193	.452	11.5	,,	5	,,
R 3194	.462	10	,,	4	,,
R 3195	.472	10	,,	5	,,
R 3196	.483	10	,,	5	,,
R 3197	.493	10	,,	5	,,
R 3198	.508	10	,,	5	,,
R 3199	.520	10	,,	4	,,
R 3218	33 763.406	10	Guilleminot Superfulgur	5	Detre
R 3219	.420	10.5	,,	4	,,
R 3220	.442	10	,,	5	,,
R 3221	.455	10	,,	4	,,
R 3222	.464	10	,,	5	,,
R 3223	.483	10	,,	5	,,
R 3224	.494	10	,,	5	,,
R 3225	.504	10	,,	5	,,
R 3226	.514	10	,,	5	,,
R 3227	.525	10	,,	4	,,
R 3479	34 118.355	15	,,	1	Lovas
R 3480	.372	15	,,	1	,,
R 3481	.388	15	Agfa Astro Spezial	2	,,
R 3482	.428	15	Guilleminot Superfulgur	3	,,
R 3483	.443	15	,,	4	,,
R 3484	.470	17	,,	3	,,
R 3485	.485	15	,,	4	,,
R 3486	.499	15	,,	4	,,
R 3487	.513	15	,,	4	,,
R 3488	.526	15	,,	2	,,
R 3489	.540	16	,,	3	,,
R 3496	34 120.471	15	,,	2	,,
R 3497	.484	15	,,	3	,,
R 3498	.497	15	,,	3	,,
R 3499	.510	14	,,	3	,,
R 3500	.523	15	,,	3	,,
R 3501	.536	15	,,	3	,,
R 3502	.551	15	,,	4	,,
R 3503	.564	15	,,	4	,,
R 3504	.579	15	,,	3	,,
R 3511	34 121.401	10	,,	2	,,
R 3512	.412	10	,,	2	,,
R 3513	.422	10	,,	3	,,
R 3514	.431	10	,,	2	,,
R 3515	.441	10	,,	3	,,
R 3516	.484	12	,,	4	,,
R 3517	.495	12	,,	4	,,
R 3518	.505	12	,,	4	,,
R 3519	.517	13	,,	3	,,
R 3520	.528	12	,,	4	,,
R 3521	.539	12	,,	4	,,
R 3522	.552	12	,,	4	,,
R 3523	.562	12	,,	2	,,

Table 1 (continued)

Plate	J. D. 2 400 000 +	Exp. time in minutes	Kind of plate	Quality of plate	Observer
R 3526	34 121.594	12	Guilleminot Superfulgur	3	Lovas
R 3527	.605	12	..	1	..
R 3535	34 122.404	12	..	2	..
R 3536	.416	12	..	3	..
R 3537	.431	13	..	3	..
R 3565	34 126.433	13	..	4	..
R 3589	34 131.415	12	..	2	..
R 3828	34 487.347	12	..	2	..
R 3829	.367	12	..	3	..
R 3830	.385	12	..	3	..
R 3831	.397	12	..	2	..
R 3832	.410	12	..	3	..
R 3833	.428	12	..	3	..
R 3834	.438	12	..	4	..
R 3835	.449	12	..	3	..
R 3836	.460	12	..	3	..
R 3837	.474	12	..	3	..
R 3838	.483	12	..	3	..
R 3839	.494	12	..	3	..
R 3840	.508	12	..	2	..
R 3841	.518	12	..	3	..
R 3850	34 488.530	12	..	3	..
R 3851	.540	12	..	4	..
R 3927	34 567.388	15	..	4	..
R 4287	35 223.415	15	..	4	Ozsváth
R 4288	.428	15	..	3	..
R 4289	.441	15	..	4	..
R 4291	.467	15	..	4	..
R 4292	.490	15	..	3	..
R 4293	.503	15	..	3	Lovas
R 4294	.517	15	..	4	..
R 4296	.530	15	..	3	Ozsváth
R 4297	.546	15	..	3	..
R 4299	.573	15	..	4	..
R 4301	35 224.454	15	..	4	..
R 4302	.472	15	..	4	Lovas
R 4303	.485	15	..	4	Ozsváth
R 4304	.499	15	..	3	Lovas
R 4305	.512	15	..	4	Ozsváth
R 4306	.524	15	..	3	..
R 4307	.542	15	..	3	Lovas
R 4308	.556	15	..	3	Ozsváth
R 4309	.569	15	..	3	Lovas
R 4310	.583	15	..	3	Ozsváth
R 4311	35 227.534	15	..	3	Lovas
R 4312	.547	15	..	2	..
R 4313	.560	15	..	3	..
R 4314	.573	15	..	3	..
R 4315	.586	15	..	3	..
R 4492	35 598.507	15	..	4	..
R 4493	.524	15	..	4	..
R 4494	.537	15	..	3	..
R 4505	35 600.363	15	..	3	..
R 4506	.378	15	..	3	..
R 4507	.391	15	..	3	..
R 4508	.405	15	..	3	..

Table 1 (continued)

Plate	J. D. 2 400 000	exp. time in minutes	Kind of plate	Quality of plate	Observer
R 4509	35 600.421	15	Guilleminot Superfulgur	3	Lovas
R 4510	.434	15	,,	3	,,
R 4511	.446	15	,,	3	,,
R 4513	.501	15	,,	2	,,
R 4515	.525	15	,,	3	,,
R 4519	35 603.369	15	,,	3	,,
R 4520	.381	15	,,	4	,,
R 4521	.397	15	,,	3	,,
R 4522	.408	15	,,	3	,,
R 4523	.419	15	,,	3	Ozsváth
R 4524	.431	15	,,	3	Lovas
R 4525	.446	15	,,	4	,,
R 4526	.457	15	,,	3	,,
R 4527	.468	15	,,	4	,,
R 4529	.491	16	,,	3	,,
R 4530	.507	16	,,	3	,,
DR 1571	35 920.444	15	Kodak OaO	4	Ozsváth
DR 1572	.467	15.5	,,	3	,,
DR 1573	.487	16	,,	3	,,
DR 1574	.504	15	,,	4	,,
DR 1575	.547	15	,,	4	,,
DR 1576	.562	14.5	,,	4	,,
DR 1577	.585	15	,,	4	,,
DR 1578	35 933.415	12	,,	4	,,
DR 1579	.443	12	,,	3	,,
DR 1582	.479	12	,,	4	,,
DR 1583	.503	12	,,	2	,,
DR 1584	.515	12	,,	2	,,
DR 1585	.530	12	,,	2	,,
DR 1586	.543	12	,,	1	,,
DR 1587	.573	12	,,	1	,,
DR 1588	.588	12	,,	1	,,
DR 1589	.602	12	,,	1	,,
R 4683	36 991.457	15	Agfa Astro Spezial	1	Lovas
R 4684	.470	15	Guilleminot Superfulgur	2	,,
R 4685	.485	14	Agfa Astro Spezial	2	,,
R 4686	37 018.470	15	,,	2	,,
R 4687	.483	15	,,	2	,,
R 4688	.496	15	,,	2	,,
R 4689	.510	16	,,	3	,,
R 4690	.523	16	,,	3	,,
R 4691	.537	15	,,	2	,,
R 4692	.550	15	,,	2	,,
R 4693	.563	15	,,	1	,,
R 4694	.577	15	,,	2	,,
R 4695	.609	15	,,	3	,,
R 4696	.623	15	,,	2	,,
R 4697	.637	15	,,	1	,,
R 4701	37 057.539	15	,,	4	,,
R 4702	.552	15	,,	3	,,
R 4703	.578	15	,,	3	,,
R 4704	37 058.529	15	,,	4	,,
R 4706	.580	15	,,	2	,,
R 4796	37 757.598	15	,,	1	Szeidl
R 4798	37 791.365	14	Kodak 103aO	4	,,
R 4799	.380	14	,,	4	,,

Table 1 (continued)

Plate	J. D. 2 400 000 +	exp. time in minutes	Kind of plate	Quality of plate	Observer
R 4800	37 791.394	14	Kodak 103aO	4	Szeidl
R 4801	.424	14	,,	3	,,
R 4802	.439	15	,,	5	,,
R 4803	.454	14	,,	3	,,
R 4804	.469	15	,,	5	,,
R 4805	.483	14	,,	4	,,
R 4806	.497	14	,,	5	,,
R 4807	.519	14	,,	5	,,
R 4808	.533	14	,,	4	,,
R 4809	.549	14	,,	5	,,
R 4810	.563	14	,,	5	,,

THE MEASUREMENTS OF THE VARIABLES

32 stars, covering an interval of nearly 3 magnitudes (14.00–17.05), were selected as comparison stars from Sandage's primary photoelectric and secondary photographic sequence (1953). They are situated at distances of 3′ to 13′ from the centre of the cluster, where photographic background and crowding effects may be considered as insignificant.

Generally it was possible to measure 117 variables of the RR Lyrae-type using the Rosenberg microphotometer of the Konkoly Observatory. The plates obtained in 1960 were measured with the Becker iris-photometer of the observatory. The errors of measurements near the centre of the cluster were considerably higher for the latter plates. Evidently a constant diaphragm is more suitable for measurements in case of great photographic density. About 60% of the plates were measured by Dr. Ozsváth. The resulting magnitudes are given in Table 9.

The mean error of the measures varies strongly with the quality of the plates and with the brightness of the stars. The data in Table 2 were determined from 15 plates, selected randomly from plates of different quality. The average error of one magnitude determination is $\pm 0^m095$.

Table 2.

MEAN ERROR OF ONE MEASUREMENT

Magnitude \ Quality of plates	5	4	3	2	1
$14^m5 - 15^m5$	±0.06	±0.07	±0.08	±0.09	±0.12
$15^m5 - 16^m5$	±0.07	±0.10	±0.12	±0.13	±0.15

DETERMINATION OF EPOCHS

Using the periods given in Sawyer's catalogue (1955) provisional phases were computed for every observation. The light curves were constructed for every year separately, and from these averages O—C values were obtained, which served for improving the periods. With the new period a new O—C diagram was constructed and that was used to plot the whole Budapest material according to phase. The mean light curves obtained in this way enabled the determination of accurate epochs even from a section of the descending branch.

The observations were divided into groups according to phase. For RRc and long period RRab stars the period was divided into 20 equal intervals, whereas for RRab stars of period about $0^{d}.5$ with steep rise the intervals were shorter on the ascending branch and around the maximum. For each group the average phase and magnitude have been calculated. The resulting normal points are given in Figures 15—27 and in Table 7. Care has been taken that the groups contained nearly linear parts of the light curves without larger gaps and that especially the brightness of the maxima and minima should not be distorted. Therefore not all normal points contain the same number of observations, accordingly they have different weights. Normal points containing four or less observations are denoted by circles.

Since the Hamburg observations of 1957 deviated systematically from the Budapest material, they were neglected in constructing the normal points. In case of variables exhibiting strong variations of the light curve the observed lowest and highest maxima were plotted, whereas in the minimum and on the descending branch mean values were taken.

The characteristics of the light curves obtained from our material are listed in Table 3. The consecutive columns contain the designation of the variable, the period, the magnitude in maximum, the magnitude in minimum, the median magnitude (mean of max. and min.), the amplitude, ε: the time interval between minimum and maximum in fraction of the period.

When the period P changes linearly with the time t, we may put $P = P_0 + \beta (t - t_0)$. If P_0 and t are expressed in days, then β is equal to the period change during one day. β is given in column 8 of Table 3. In the following columns c_1, c_2 and $c = c_1 + c_2$ are indices illustrating the complexity of the O—C diagrams. They will be explained later. In column 12 the letter *i* denotes definite light curve changes, the same letter with an interrogation mark indicates possible changes in the light curve. In the last column *r* gives the distance from the centre of the cluster in minutes of arc.

Table 3.

Var	Period	M	m	m_{med}	A	ε	$\beta \cdot 10^{10}$	c_1	c_2	c	B_{eff}	r
1	$0^d.5206250$	$14^m.68$	$15^m.92$	$15^m.30$	$1^m.24$	$0^P.13$	−11.3	2	0	2		2′.1
5	.5058940	14.71 15.43	16.15	15.61	1.44 0.72	—	—	5	3	8	i	4.4
6	.5143228	14.87	16.21	15.54	1.34	0.13	4.1	1	0	1		2.3
9	.5415641	14.95	16.28	15.61	1.33	0.13	− 5.3	1	0	1		6.0
10	.5695185	15.06	16.15	15.60	1.09	0.16	−11.4	2	0	2	i	3.5
11	.5078918	14.75	16.17	15.46	1.42	0.14	0.0	0	0	0		4.3
12	.3178890	15.23	15.83	15.53	0.60	0.35		3	3	6	i	2.4
13	.4830490	14.79	15.96	15.37	1.17	0.15	− 9.4	2	0	2	i?	2.3
14	.6359019	14.95	16.19	15.57	1.24	0.15	1.0	0	0	0	i	2.5
15	.5300794	14.87	16.26	15.56	1.39	0.11	4.1	1	0	1		4.8
16	.5115075	14.93	16.31	15.62	1.38	0.12	− 4.9	1	0	1		5.2
17	.5761367	15.20 15.60	16.20	15.80	1.00 0.60	—	6.0	2	2	4	i	7.7
18	.5163623	14.86 15.22	16.30	15.67	1.44 1.08	0.11 0.16	—	3	2	5	i	5.2
19	.6319796	15.56	16.15	15.85	0.59	0.21	2.3	1	0	1		7.1
20	.4912570	14.85	16.25	15.55	1.41	—	—	2	1	3	i	7.2
21	.5157286	14.92	16.42	15.67	1.50	0.12	16.5	2	0	2		5.8
22	.4814221	14.98	16.20	15.59	1.22	—	—	5	2	7	i	3.2
23	.5953756	15.07	15.80	15.43	0.73	0.18		1	1	2	i?	5.1
24	.6633494	15.06	16.07	15.56	1.01	0.17	0.0	0	0	0		2.5
25	.4800510	14.66	16.07	15.36	1.41	0.10	− 6.3	5	0	5	i?	2.2
26	.5977452	14.88	16.04	15.46	1.16	0.14	− 1.0	0	0	0		3.1
27	.5790912	15.07	16.11	15.59	1.04	0.15	—	2	0	2		2.5
28	.4706364	14.92	15.88	15.40	0.96	0.23	—	2	4	6	i	1.8
31	.5807216	14.43	15.65	15.04	1.22	0.14	1.9	1	0	1		1.3
32	.4953518	14.58	15.68	15.13	1.10	0.11	− 1.4	1	0	1		1.0
33	.5252237	14.78 15.24	15.90	15.45	1.12 0.66	—	2.9	1	0	1	i	1.9
34	.5591012	15.08 15.44	16.16	15.71	1.08 0.72	—		3	3	6	i	3.6
35	.5306059	15.04 15.50	16.10	15.69	1.06 0.60	0.14 0.22		5	1	6	i	4.9
36	.5455855	14.78	16.26	15.52	1.48	0.12	2.2	1	1	2		3.0
37	.3266390	15.41	16.03	15.72	0.62	0.37	0.9	1	0	1		4.8
38	.5580276	14.74 15.34	16.16	15.60	1.42 0.82	—	7.1	2	0	2	i	4.0
39	.5870766	15.14 15.56	16.23	15.79	1.09 0.67	—	—	1	2	3	i	4.6
40	.5515411	15.09	16.32	15.70	1.23	0.13	0.0	0	0	0		4.9
41	.4850462	15.22	16.23	15.72	1.01	—	—	3	1	4	i?	1.8
42	.5901852	14.40	15.68	15.04	1.28	0.16	−36.5	4	0	4	i?	1.5
43	.5404790	14.40 15.04	15.80	15.26	1.40 0.76	—	—	5	3	8	i	1.7
44	.5063961	14.84 15.36	16.04	15.57	1.20 0.68	—		4	2	6	i	3.3
45	.5368966	14.94	16.23	15.58	1.29	0.13	2.0	1	0	1	i?	4.6
46	.6133669	15.32	15.96	15.64	0.64	0.23	5.2	1	0	1		2.3
47	.5409923	14.74 15.40	15.97	15.52	1.23 0.57	—	—	1	3	4	i	2.3
48	.6278128	15.23	15.92	15.57	0.69	0.22	4.5	1	0	1	i?	2.7
49	.5482196	14.71 15.39	16.11	15.58	1.40 0.72	0.12 0.22	− 5.6	1	0	1	i	2.9
50	.5130879	14.57 15.21	16.09	15.49	1.52 0.88	—	—	2	3	5	i	3.9
51	.5839818	15.16	16.18	15.67	1.02	0.15	− 5.8	1	0	1		3.8

Table 3 (continued)

Var	Period	M	m	m_{med}	A	ε	$\beta \cdot 10^{10}$	c_1	c_2	c	B_{eff}	r
52	$0^{\mathrm{d}}.5162250$	$14^{\mathrm{m}}.92$ 15.23	$16^{\mathrm{m}}.06$	$15^{\mathrm{m}}.57$	$1^{\mathrm{m}}.14$ 0.83	—	—	3	2	5	i	2.9
53	.5048878	14.68	15.93	15.30	1.27	$0^{\mathrm{p}}.13$	— 2.5	1	0	1		2.0
54	.5063150	14.92	15.94	15.43	1.02	0.17	—	5	3	8	i	1.9
55	.5298132	14.95	16.29	15.62	1.34	0.13	+ 3.6	1	0	1		6.4
56	.3295986	15.38	16.02	15.70	0.64	0.34	—	0	2	2		6.5
57	.5122223	14.84	16.23	15.53	1.39	0.15	—14.2	2	0	2		2.6
58	.5170617	14.58	15.91	15.24	1.33	0.12	—	5	1	6	i?	1.6
59	.5888053	15.23	16.20	15.71	0.97	0.16	+ 5.9	1	0	1	i	4.2
60	.7077228	15.24	16.15	15.69	0.91	0.19	+ 2.3	1	0	1		7.2
61	.5209312	14.96 15.42	16.21	15.70	1.25 0.79	—	—	2	3	5	i	6.8
62	.6524077	15.42	16.16	15.79	0.74	0.21	+ 2.9	1	0	1	i	7.2
63	.5704164	14.96 15.36	16.22	15.69	1.26 0.86	0.14 0.18	— 6.5	1	0	1	i	5.7
64	.6054588	15.39	16.24	15.81	0.85	0.21	0.0	0	0	0		5.8
65	.6683397	15.10	16.21	15.65	1.11	0.18	—	1	1	2		5.9
66	.6201827	15.20	15.93	15.56	0.73	0.17	—	2	4	6	i	2.6
67	.5683609	14.95 15.44	16.07	15.64	1.12 0.63	—	—14.2	2	0	2	i	3.0
68	.3559732	15.0 15.7	16.0	15.8	1.0 0.3		—	—	—	—	i	2.9
69	.5665878	15.15	16.05	15.60	0.90	0.18	+12.2	2	0	2		2.7
70	.486:	15.22	15.75	15.48	0.53	—	—	—	—	—		2.6
71	.5490517	15.07	16.04	15.55	0.97	0.15	—	1	1	2		2.7
72	.4560739	14.80	16.30	15.55	1.50	0.13	+ 2.0	1	0	1		7.4
74	.4921441	14.80	16.20	15.50	1.40	0.14	—	1	1	2		2.9
75	.3140790	15.38	15.98	15.68	0.60	0.36	—	1	1	2		2.8
76	.5017544	14.90	16.46	15.68	1.56	0.13	—	1	1	2		1.5
77	.4593425	14.63	16.07	15.35	1.44	0.13	+ 1.7	1	1	2		1.7
78	.6119254	14.92	15.70	15.31	0.78	0.19	—	1	0	1		1.4
79	.4833275	14.72 15.19	16.31	15.63	1.59 1.12	0.11 0.17	—	4:	3:	7	i	5.8
80	.5384827	14.80 15.50	16.17	15.66	1.37 0.67	—	—	5	3	8	i	8.3
81	.5291105	15.00	16.28	15.64	1.28	0.15	—	1	1	2		8.2
82	.5245061	14.96	16.31	15.63	1.35	0.12	+ 8.6	2	0	2		10.1
83	.5012408	14.87	16.32	15.59	1.45	0.12	+ 9.6	2	0	2		7.6
84	.5957289	15.26	16.12	15.69	0.86	0.18	— 1.2	0	0	0		3.0
85	.3558189	15.32	15.92	15.62	0.60	0.38	—	1	4	5		6.4
86	.2926601	15.42	16.06	15.74	0.64	0.41	—	1	2	3		8.8
87	.3574814	15.13	15.68	15.40	0.55	0.34	—	1	1	2	i	2.1
88	.2985092	15.08	15.67	15.37	0.59	0.36	—	2	1	3		1.3
89	.5484779	14.85	15.93	15.39	1.08	0.13	—	0	1	1		1.9
90	.5170334	14.92	16.25	15.58	1.33	0.14	—	0	1	1		3.5
91	.5301630	14.95	16.26	15.60	1.31	0.15	—14.1	2	0	2	i?	9.2
92	.5035553	14.94	16.30	15.62	1.36	0.15	—	1	1	2	i	6.8
93	.6022991	15.24	16.25	15.74	1.01	0.21	—	1	1	2		8.5
94	.5236937	14.94:	16.34	15.64	1.40:	0.13:	0.0	0	0	0		8.9
96	.4994467	14.74	16.10	15.42	1.36	0.14	—12.6	2	0	2		4.7
97	.3349289	15.53	16.04	15.78	0.51	0.39	+ 1.6	1	0	1		4.0
100	.6188126	15.31	15.96	15.63	0.65	0.21	— 1.2	0	0	0		2.0
101	.6438975	15.29	15.78	15.53	0.49	0.22	— 3.3	1	0	1		1.6
104	.5699231	14.73	15.99	15.36	1.26	0.14	— 1.4	0	0	0		2.4
105	.2877427	15.33	15.72	15.52	0.39	0.37	—	1	2	3		3.2
106	.5471593	15.18	16.04	15.61	0.86	0.17	—	1	2	3	i	2.9
107	.3090351	15.40	16.04	15.72	0.64	0.34	—	1	4	5		5.7

Table 3 (continued)

Var	Period	M	m	m_{med}	A	ε	$\beta \cdot 10^{10}$	c_1	c_2	c	B_{eff}	r
108	$0^d.5196049$	$15^m.07$	$16^m.34$	$15^m.70$	$1^m.27$	$0^P.17$	—	1	1	2		$6'.3$
109	.5339239	14.56	15.64	15.10	1.08	0.15	—	1	1	2		1.5
110	.5353569	15.02	15.88	15.45	0.86	—	—	5	2	7	i	1.7
113	.5130066	14.90	16.25	15.57	1.35	0.11	—	1	1	2		12.0
114	.5977270	15.18	16.24	15.71	1.06	0.16	0.0	0	0	0		10.4
115	.5133529	14.98	16.34	15.66	1.36	0.12	− 0.8	0	0	0		13.4
116	.5148088	14.89	16.32	15.60	1.43	0.13	—	1	1	2		11.3
117	.6005164	15.22	16.22	15.72	1.00	0.20	—	1	1	2	i	7.9
118	.4993807	14.90	16.36	15.63	1.46	0.12	− 1.4	0	0	0		5.5
119	.5177404	14.87	16.23	15.55	1.36	0.16	—	1	2	3		4.6
120	.6401387	15.56	16.07	15.81	0.51	0.27	0.0	0	0	0		6.3
121	.5351882	14.84	15.54	15.19	0.70	—	—	1	1	2	i	1.1
123	.5454472	14.92	16.31	15.61	1.39	0.14	—	2	1	3		17.0
124	.7524328	15.50	15.96	15.73	0.46	0.30	—	1	1	2		3.6
125	.3498206	15.48	16.00	15.74	0.52	0.41	− 2.9	1	0	1		3.8
126	.3484043	15.42	15.96	15.69	0.54	0.36	—	0	2	2		2.4
131	.2976919	15.04	15.56	15.30	0.52	0.40	—	1	1	2		1.3
140	.3331304	15.07	15.51	15.29	0.44	0.36	0.0	—	—	—		1.8
142	.5686256	14.79	15.72	15.25	0.93	0.19	0.0	—	—	—		1.1

In Figure 1 the median magnitude of the variables (m_{med}) and $A - \bar{A}$ have been plotted against the distance from the centre of the cluster, where A is the amplitude of the light curve and $\bar{A}$ is the mean amplitude in the P – A relation for the period in question. For small distances the median magnitudes are systematically too bright, the amplitudes too small, because due to photographic effects the measurements give too high values for the brightness of the stars near the centre of the cluster, and this effect is greater for faint stars than for bright ones. W. Chr. Martin has investigated the same photographic effects in ω Centauri (1938) with similar results.

These photographic effects are especially pronounced for $r < 2'.5$. For variables at distances smaller than $2'.5$ from the centre the characteristics of the light curves may be strongly distorted. Accurate photometry is out of question near the centre. Therefore in the further discussions about the characteristics of the light curves variables with $r < 2'.5$ were left out of consideration.

The epochs used for the construction of the O – C diagrams are listed in tables following the remarks on every individual variable. To make the material as homogeneous as possible it was necessary to determine every epoch anew. The necessity of this procedure is especially evident for stars with variable light curve. But to homogenize the materials obtained by different observers is a difficult problem. The observations have been obtained with different instruments using different kinds of photographic plates and exposure times. Long exposure time may distort the light curve considerably. Colour equations (Kukarkin and Kukarkina, 1961 a) cannot be applied in most cases because the colour indices of several variables, especially of those having variable light curves, are unknown. For stars exhibiting regular light curve the median magnitude on the ascending branch can be simply used for determination of the epochs. Mean epochs have been obtained from a year's material plotted against phase. When the rising branch was actually observed, the mean error of one epoch is about $0^d.001 - 0^d.003$, depending on the amplitude and the steepness

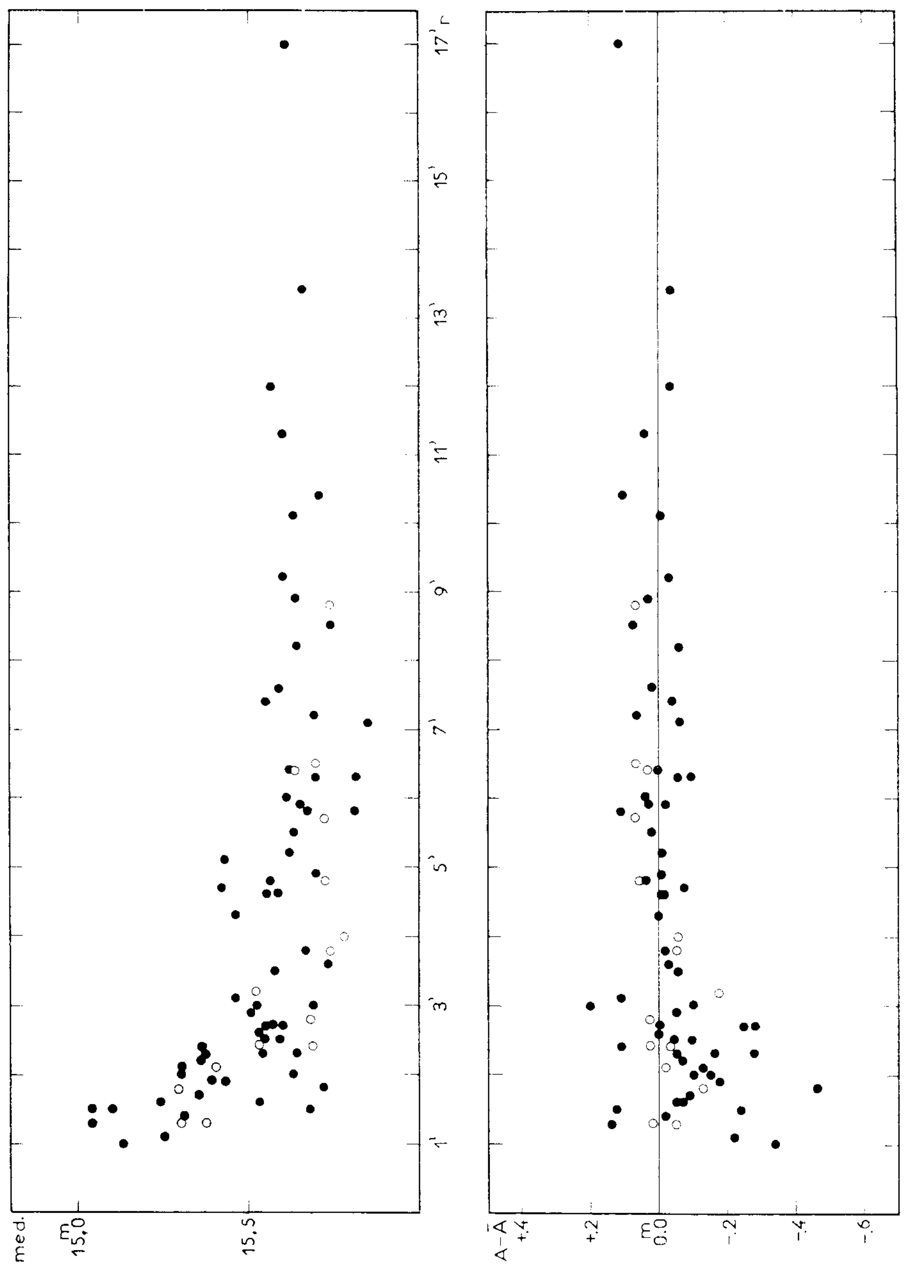


Figure 1.

of the rising branch. When the rising branch has not been observed, the descending branches have been fitted to a mean light curve based on all of the observations available for the star. The error of epochs determined in this way may amount to $\pm 0^{d}.01$.

For stars with variable light curve the determination of "the middle of the rising branch" is very problematic. E.g. $\frac{1}{2}(M_{max} + m_{min})$ may be sometimes fainter than M_{min}. Considering the Budapest material, the arithmetic mean of the average maximum and minimum was taken as median magnitude for stars exhibiting light curve changes:

$$m_{med} = 1/4\,(M_{max} + M_{min} + m_{max} + m_{min}).$$

This definition proved to be satisfactory with the exception of Var. 68, where the median magnitude defined in this way is fainter than M_{min}. Therefore the epochs for this star belong to the magnitude $m_{Bp} = 15.8$ on the rising branch.

We should like to make it perfectly clear that the M_{max} and M_{min} values in Table 3 are the highest and lowest maxima observed in Budapest and they may differ from the real extreme values of the maxima, as in most cases the cycle of the light curve changes is not fully covered. Besides M_{max} and M_{min} may change from year to year as in the case of field stars showing the Blashko-effect. The variations in the brightness of the minima are rather small, therefore we have used for every star an average value of the minimum. In order to get consistent epochs we had to determine equivalent points on the rising branches obtained by different observers. For this purpose the following procedure has been used. The half amplitudes of the variables having stable light curves and situated at $r > 2'.5$ have been compared with the Budapest data. The diagrams 2a–i obtained in this way enable us to transform the Budapest magnitude intervals into the corresponding data obtained by other observers. In principle the curves should pass the origo, but in the range of 0^m2 – 0^m8 the following linear approximations seem to be satisfactory:

a) Bailey 1895–1900, $n = 57$

$$\Delta m_B = \underset{\pm .065}{1.220}\,\Delta m_{Bp} \underset{\pm .036}{+0.320}$$

b) Hett 1912, 1915 $n = 21$

$$\Delta m_H = \underset{\pm .049}{0.837}\,\Delta m_{Bp} \underset{\pm .025}{+0.108}$$

c) Larink 1921 $n = 54$

$$\Delta m_L = \underset{\pm .040}{0.952}\,\Delta m_{Bp} \underset{\pm 0.022}{+0.101}$$

d) Müller 1925 $n = 54$

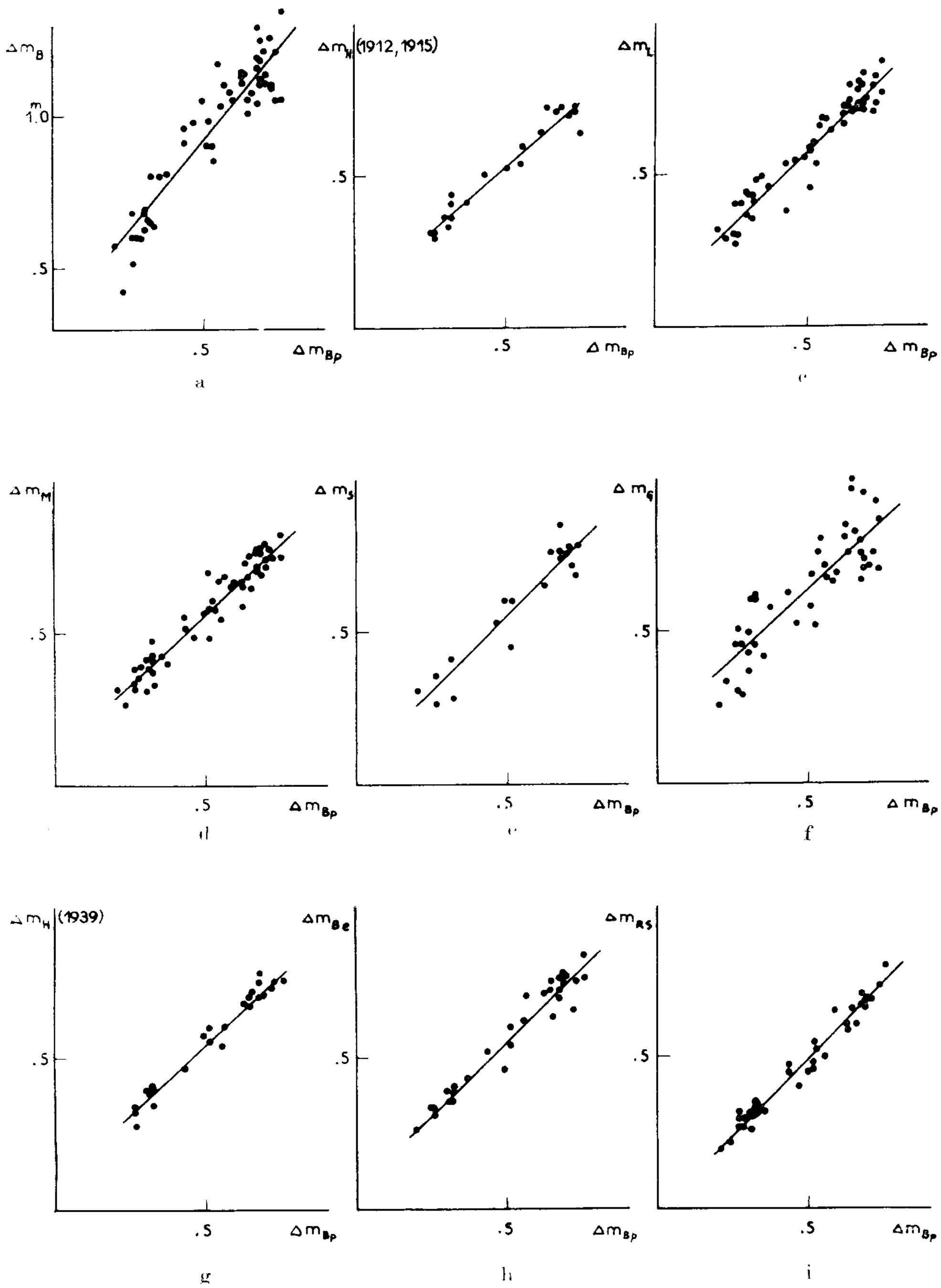
$$\Delta m_M = \underset{\pm .037}{0.921}\,\Delta m_{Bp} \underset{\pm .020}{+0.104}$$

e) Slavenas 1926 $n = 19$

$$\Delta m_S = \underset{\pm .084}{0.997}\,\Delta m_{Bp} \underset{\pm .047}{+0.061}$$

f) Greenstein 1926 $n = 45$

$$\Delta m_G = \underset{\pm .088}{0.919}\,\Delta m_{Bp} \underset{\pm .046}{+0.181}$$



Δm_B
1.0
.5
.5
Δm_Bp
a
Δm_H (1912, 1915)
.5
.5
Δm_Bp
Δm_L
.5
.5
Δm_Bp
c
Δm_M
.5
.5
Δm_Bp
d
Δm_S
.5
.5
Δm_Bp
e
Δm_G
.5
.5
Δm_Bp
f
Δm_H (1939)
.5
.5
Δm_Bp
g
Δm_Be
.5
.5
Δm_Bp
h
Δm_RS
.5
.5
Δm_Bp
i

Figure 2.

g) Hett 1939 n = 28

$$\Delta m_H = \underset{\pm .034}{0.919}\ \Delta m_{Bp} \underset{\pm\ .018}{+0.094}$$

h) Belserene 1946, 1948 n = 30

$$\Delta m_{Be} = \underset{\pm .043}{0.967}\ \Delta m_{Bp} \underset{\pm\ .024}{+0.076}$$

i) Roberts, Sandage 1953 n = 39

$$\Delta m_{RS} = \underset{\pm .029}{0.994}\ \Delta m_{Bp} \underset{\pm\ .015}{+0.000}$$

As the minimum does not change significantly in course of the light curve changes, its average value is well determined. Therefore, the median magnitude for an observer x can be defined through the relation:

$$(\mathrm{med})_x = (\mathrm{min})_x - m_x$$

where $m_x = (\mathrm{min} - \mathrm{med})_x$ can be determined from the relation $\Delta m_x = f(\Delta m_{Bp})$. The errors of $(\mathrm{med})_x$ amount to about $0^m\!.03$—$0^m\!.06$ or $0^d\!.01$.

It is not possible to construct O − C diagrams using individual maxima or minima, because the number of well observed epochs would be insufficient.

O – C DIAGRAMS AND PERIOD CHANGES

The periods in Helen B. Sawyer's catalogue (1955) have been corrected. The greatest correction, amounting to $-0^{d}.000178 \approx +15^{s}$, was applied to var. 54. For 17 variables (var. 18, 22, 28, 41, 42, 43, 44, 47, 52, 54, 58, 66, 79, 80, 88, 110, 119) corrections exceeding $0^{d}.00001 \approx 1^{s}$ were necessary. The periods given in Table 3 refer generally to J. D. 2425000, and are average values taken over more than 60 years. The O – C diagrams were constructed by using these periods, and if possible, they were approximated by a straight line or a quadratic parabola. Considering only the variables observed since Bailey's discoveries the O – C diagrams are represented by a straight line for 7 variables, by a positive parabola for 22, by a negative parabola for 25 variables. There is no systematic trend in period lenghtening or shortening.

In Figure 3 the frequency distribution of the values of $10^{10}\,\beta$ is shown, for the RRab variables. Apart from some deviations the distribution is Gaussian for M3 and M5. For M3 the mean values and their errors are compiled in the following table:

	n	$10^{10}\,\bar{\beta}$	$10^{10}\,\delta\beta$
RRc stars	4	+0.90	±0.71
RRab stars	53	−0.74	1.12
all	57	−0.63	1.05

The distributions of the β and $\delta\beta$ values according to the period are shown in Fig. 4 and given below

P	0.32		0.35		0.44		0.47		0.50		0.53		0.56		0.59		0.62		0.65		0.68		0.71
n		4				2		5		13		8		10		7		5		2		1	
$10^{10}\beta$		+0.90				−1.85		−3.14		+0.45		2.97		−0.67		−4.99		−0.02		+1.45		+2.3	
$10^{10}\delta\beta$		±0.85						±3.41		±2.31		±2.17		±2.63		±5.32		+1.37					

The irregularities in the O – C diagrams can not be generally identified with changes of the true period; they represent only statistical fluctuations around

$$\bar{P} = \int_0^\infty P\, f(P, E)\, dP,$$

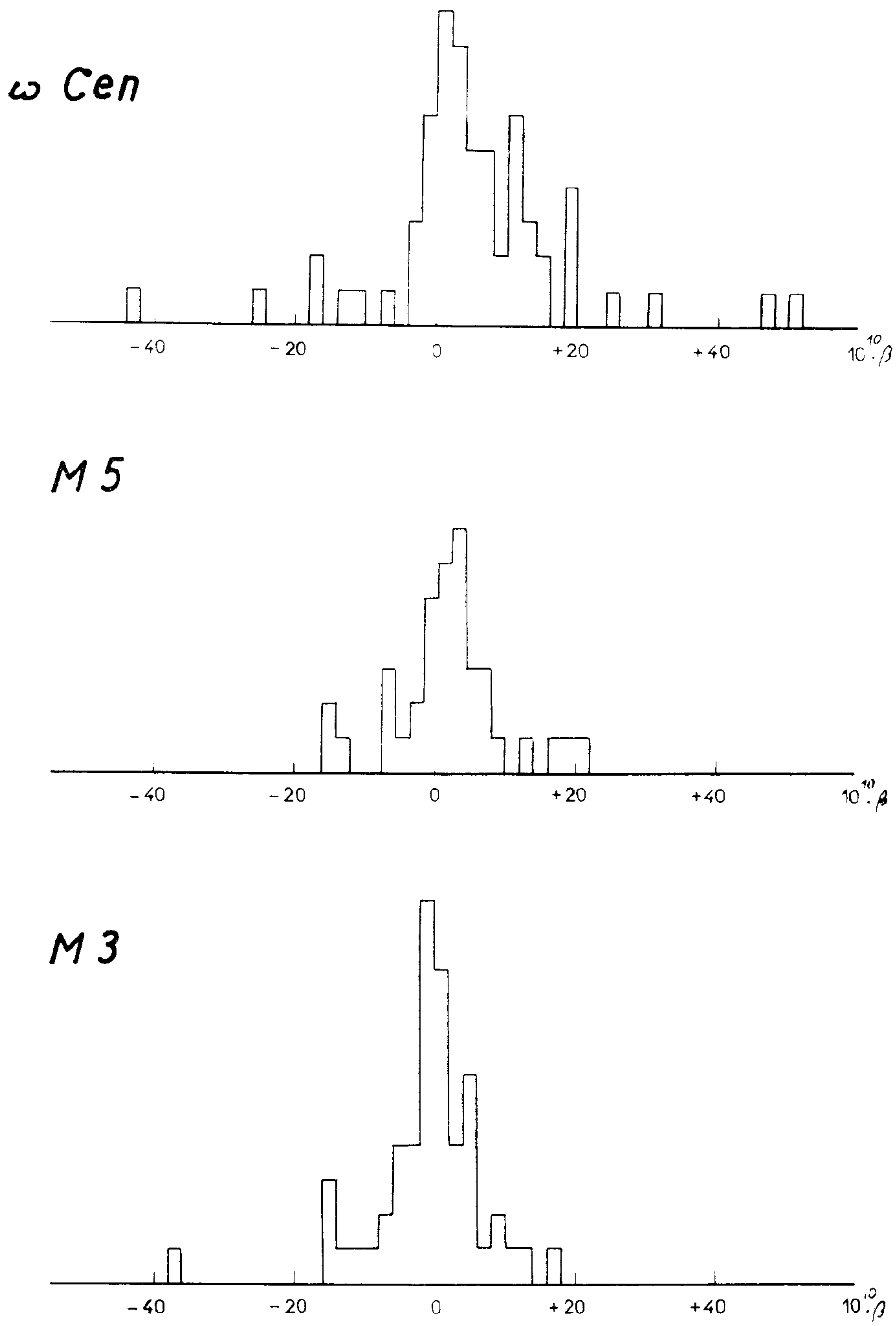

ω Cen
-40
-20
0
+20
+40
$10^{10}.\beta$
M 5
-40
-20
0
+20
+40
$10^{10}.\beta$
M 3
-40
-20
0
+20
+40
$10^{10}.\beta$

Figure 3.

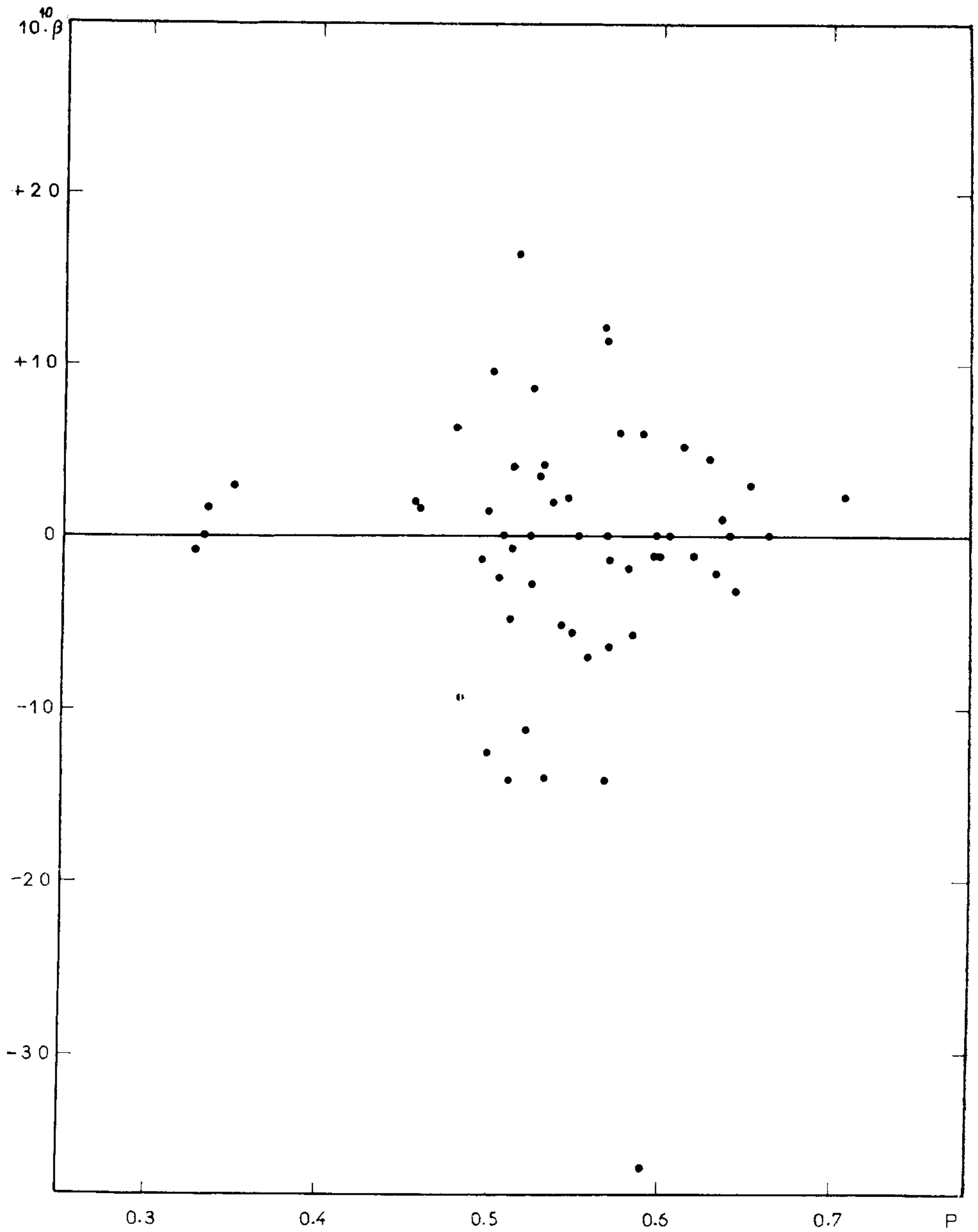


Figure 4.

the expectable value of the period. Strictly taken, the change of the period is given by the dependence of the density function f (P, E) on E (Sterne, 1934).

In M3 the O—C diagrams could be approximated by quadratic forms only for 57 variables, whereas for the majority of the variables more complicated O—C diagrams have been obtained. Especially difficult was the construc-

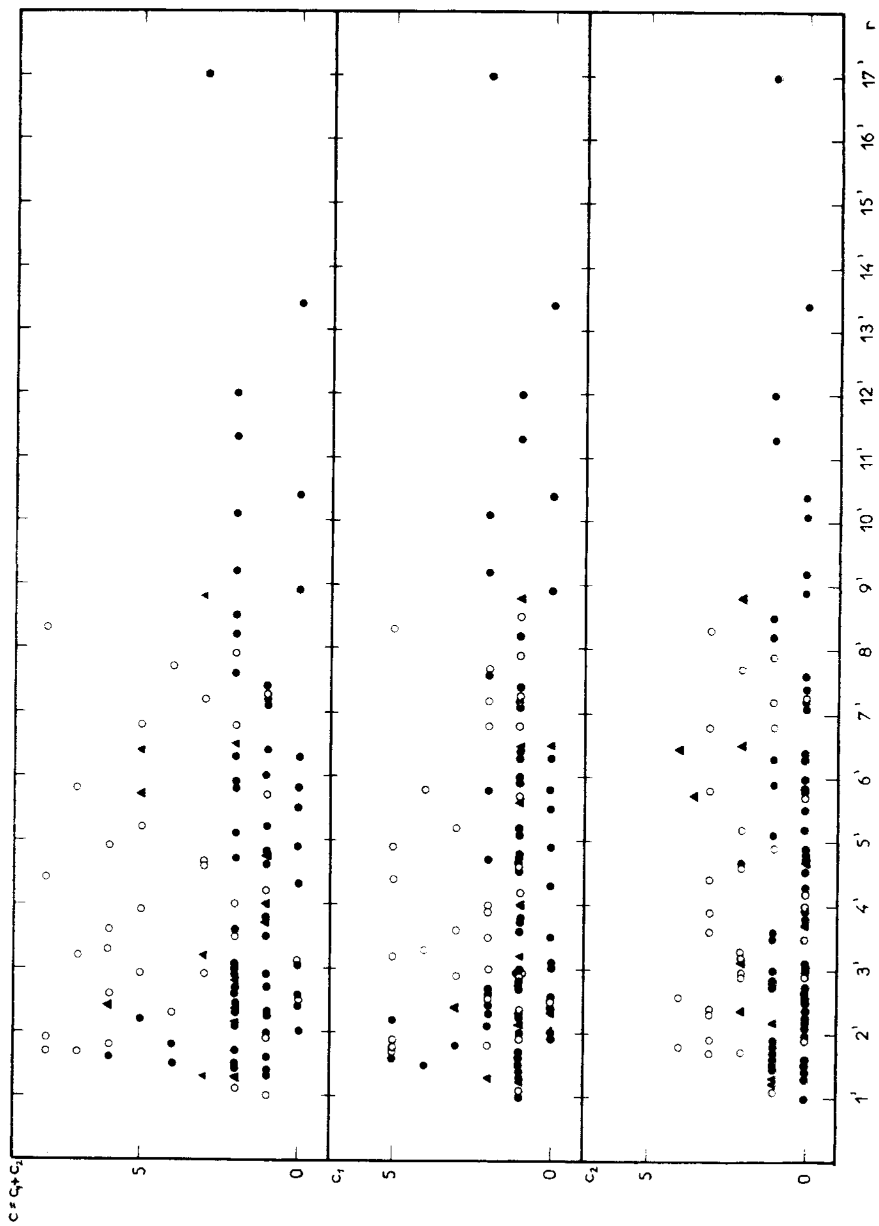


Figure 5.

tion of O—C diagrams for stars with changing light curves, because the secondary periods causing phase shifts amounting sometimes to $0\overset{d}{.}1$, were not known. Therefore these phase shifts could not be eliminated and they appeared as scatter in the O—C diagrams. We have for variables in M3 the same rule as for field RR Lyrae stars (Julia Balázs, L. Detre): RR Lyrae stars with secondary periods have very complicated O—C diagrams.

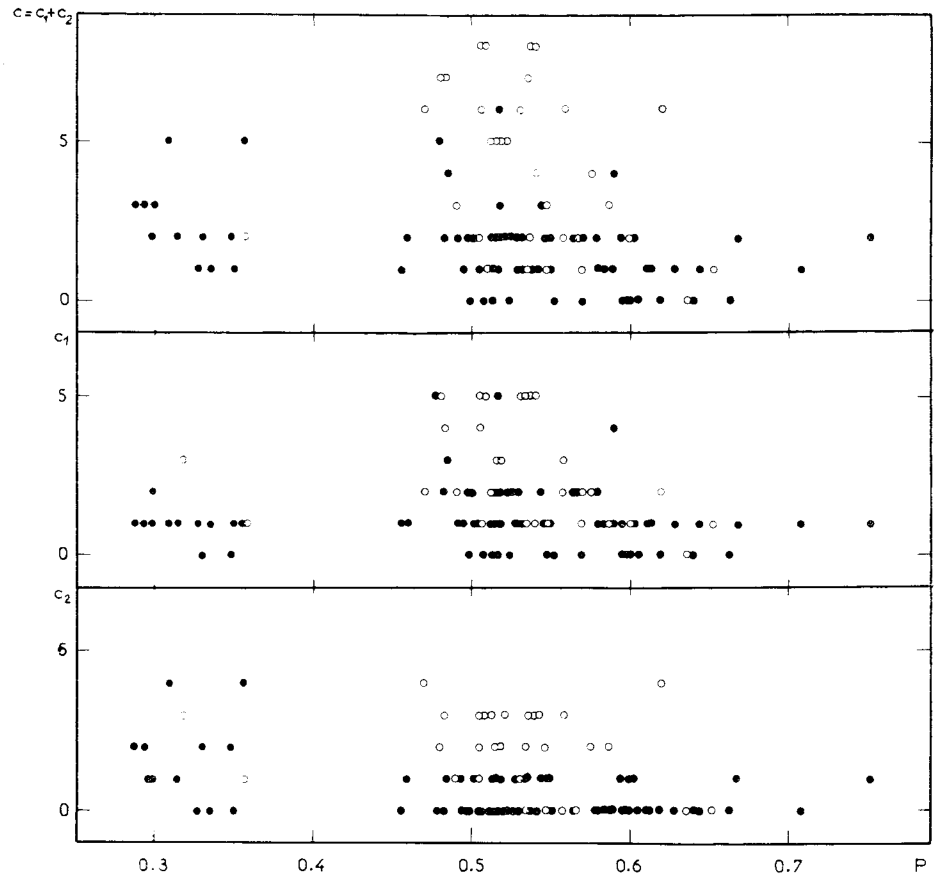


Figure 6.

The author has attempted to characterize these intricate O—C diagrams through three indices (c_1, c_2, c; Table 3). c_1 describes the extent of the O—C diagram, i.e. the amplitude of the fluctuations of the O—C values. Its dependence on the period was eliminated by using the average period over 60 years.

$c_1 = 0$	if the fluctuations of O—C are	smaller than		$0\overset{d}{.}02$
$c_1 = 1$	.. ..	between	$0\overset{d}{.}02$ and	$0\overset{d}{.}10$
$c_1 = 2$	.. ..	..	$0\overset{d}{.}01$ ..	$0\overset{d}{.}25$
$c_1 = 3$	.. ..	..	$0\overset{d}{.}25$ ..	$0\overset{d}{.}40$
$c_1 = 4$	.. ..	..	$0\overset{d}{.}40$ ..	$0\overset{d}{.}55$
$c_1 = 5$	.. ..	greater than		$0\overset{d}{.}55$

c_2 gives the number of cycles in the O—C diagram having amplitudes greater than $0\overset{d}{.}01$.

$c_2 = 0$ if the number of inflexion points is 0
$c_2 = 1$ 1
$c_2 = 2$ 2
$c_2 = 3$ 3
$c_2 = 4$ .. .. 4 or more.

As a very compact index, characterizing the complexity of the O—C diagrams, the sum

$$c = c_1 + c_2$$

can be used. In Figure 5 the indices c_1, c_2 and c are plotted against the distance from the centre. RRc stars are denoted by triangles, RRab stars having variable light curves by circles. It is obvious that RRab stars with variable light curves have generally O—C diagrams of great complexity. In the vicinity of the centre several stars occur qualified as regular (var. 25, 42, 48) nevertheless having complicated O—C diagrams. No doubt these stars are effected by the Blashko-effect, but the considerable errors of measurement make the effect indistinct near the centre. After all we can state as a rule in accordance with results obtained by Detre for field RR Lyrae stars: RRab stars having complex O—C diagrams exhibit always Blashko-effect of considerable amplitude.

Figure 6 represents the relations c_1, c_2, c versus period. Open circles are again used for stars having variable light curves. For RRc and irregular RRab stars the index c_2 is generally large, i.e. they exhibit cyclic oscillations in their O—C diagrams.

THE CHARACTERISTICS OF THE LIGHT CURVES

The caracteristics of the light curves are summarized in Table 3.

The relation with period of the amplitudes for 50 variables with a distance from the centre greater than 2'.5 is shown in the middle of Fig. 7. Sandage and Roberts' (1955) two variables of very small amplitude are also plotted in the diagram.

The break between c- and ab-type variables is evident and the figure illustrates for ab-variables the well-known decrease in amplitude with increasing period. But the points for RRab stars appear to be distributed in two sequences, as was already pointed out for cluster variables by Belserene (1954), and for field RR Lyrae stars by Detre (1955). The one on the shortperiod side (RRab I stars) is considerably steeper than the long-period sequence (RRab II stars). Also other characteristics of the light curves (ε, $\overline{B-V}$, median magnitude, m_{max} etc.) indicate a separation of RRab stars into two distinct sequences. RRab II stars behave like RRab I stars of the same amplitude having periods shorter by $0^d.1$. The separation is especially well marked in the relations m_{max} versus P (Fig. 8) and $\overline{B-V}$ versus P (Fig. 9). Constructing Fig. 9 the mean colour indices $\overline{(B-V)}$ obtained by Sandage (1959) have been used.

In M3 the variables 14, 24, 26, 60, 65 and 124 belong definitely to the RRab II sequence. Table 4 summarizes the dependence of the median magnitude on period for stars with $r > 2'.5$.

Table 4

Type		n	$\overline{P}$	$m_{med.}$
RRab I	$0^d.45 < P \leq 0^d.50$	5	$0^d.485$	$15^m.538$
	$0.50 < P \leq 0.55$	24	0.524	15.597
	$0.55 < P \leq 0.60$	9	0.581	15.633
	$0.60 < P$	8	0.623	15.731
RRab II		4	0.681	15.632
RRab all		50	0.559	15.622
RRc		9	0.322	15.691
RR all		59	0.523	15.633

Figure 10 illustrates the relation of $\varepsilon = M - m$ to the period for variables having stable light curves. RRc stars are indicated by open circles, RRab II stars by triangles. Plotting ε against the amplitude (A), instead of P (Fig. 11), the separation of RRab stars into two sequences is not apparent and the scatter

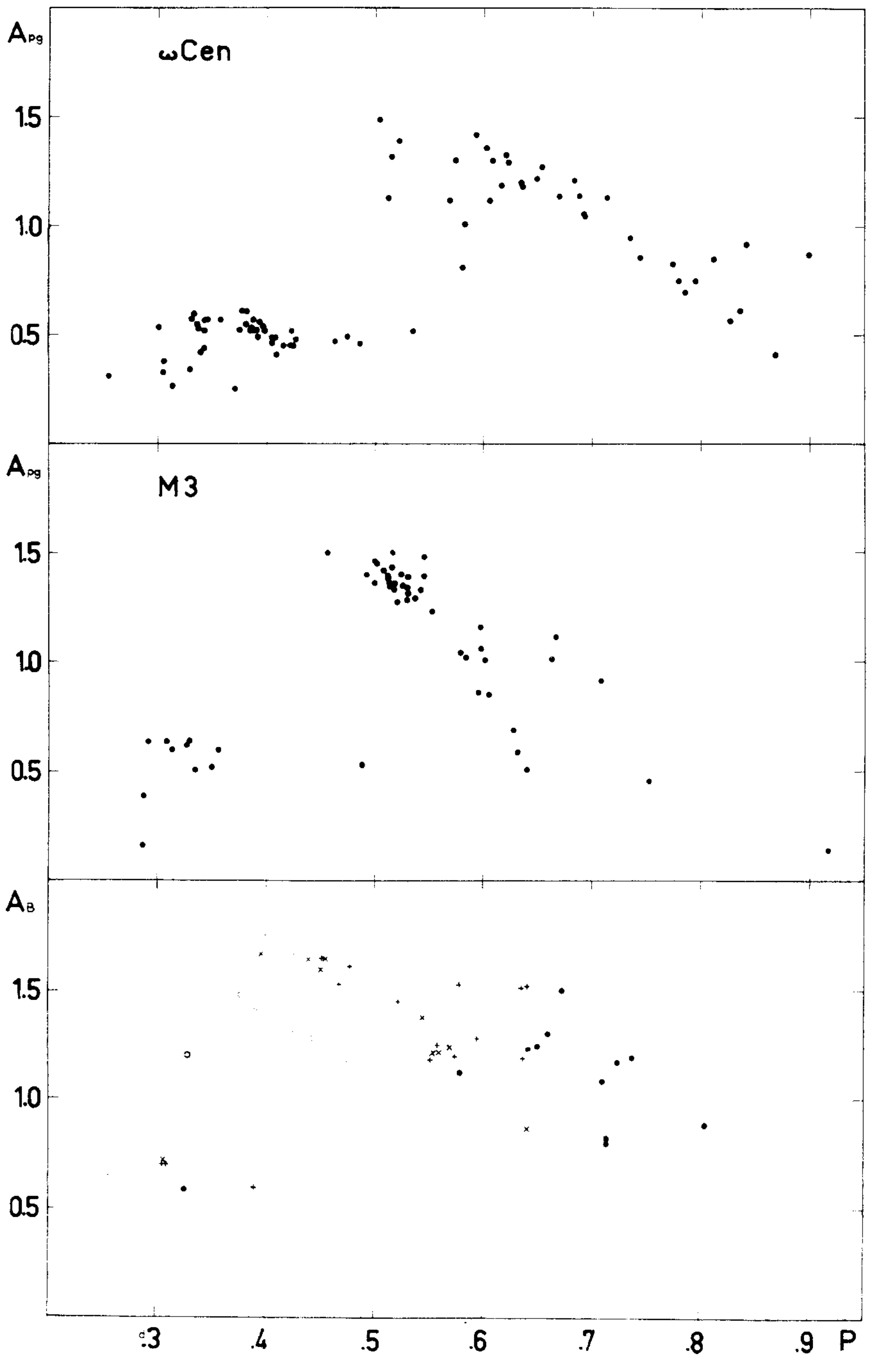


Figure 7.

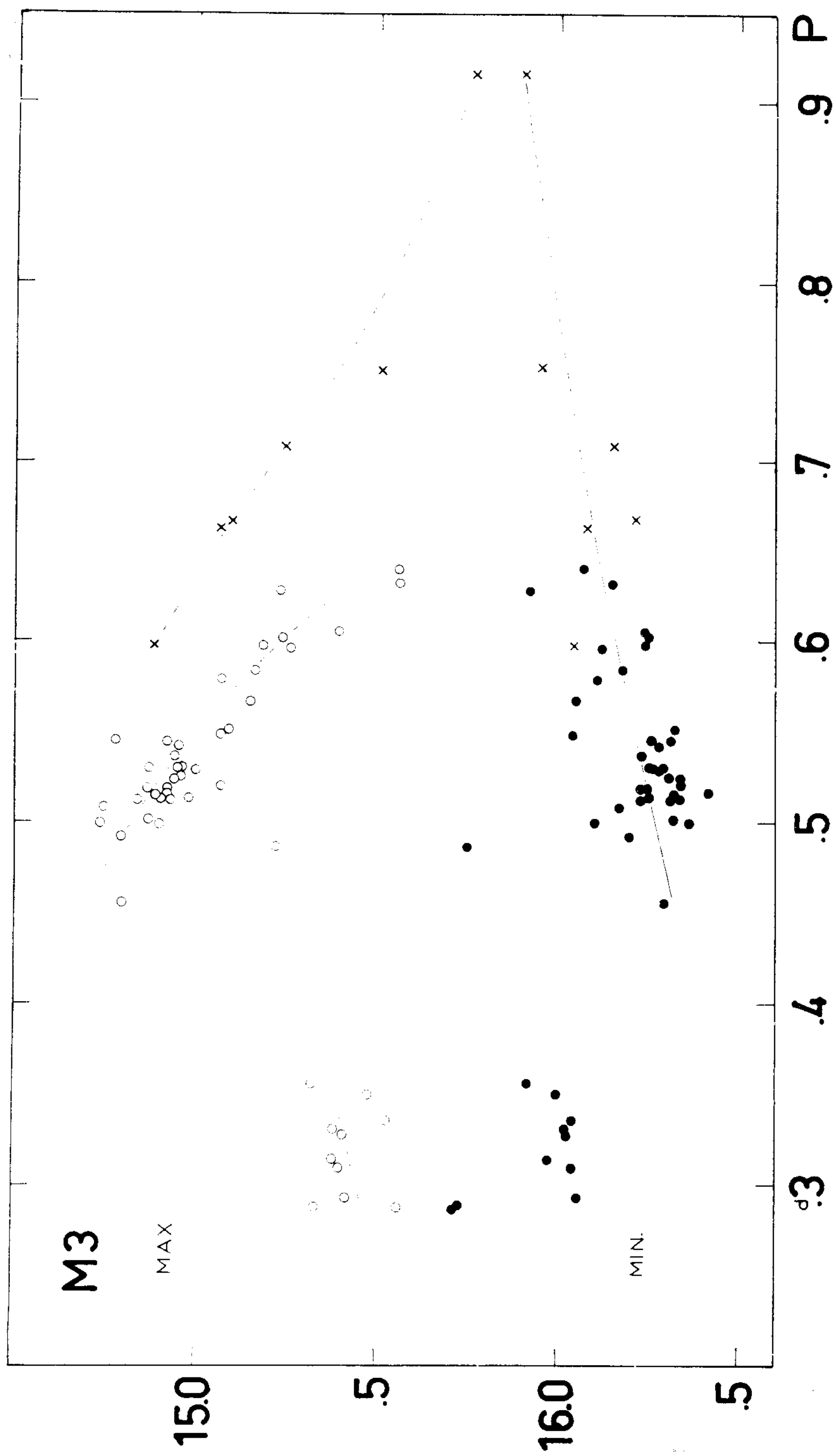


Figure 8.

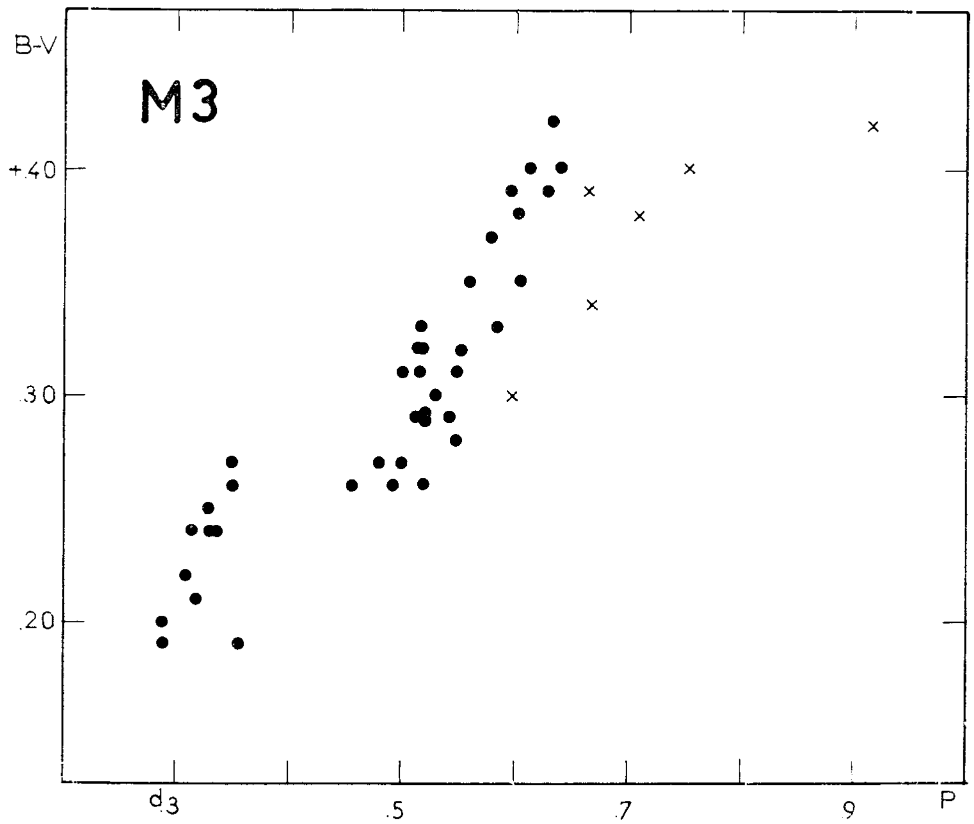


Figure 9.

becomes smaller than in Fig. 10. I. e. there exists a closer correlation between ε and A, than between ε and P. In Table 3 the observed brightest and faintest maxima are given for variables exhibiting light curve changes.

Presumably these observed data do not differ substantially from the true extreme maxima. With the observed extreme maxima Fig. 12 was constructed showing the period-amplitude relation for stars with variable light curves. The amplitudes for stars exhibiting only minute light curve changes are denoted by triangles, the greatest amplitudes by +, the smallest ones by ×. Apart from the uncertain var. 68, Fig 12 shows, that for stars having variable light curves the greatest amplitudes fit the P – A relation valid for RR Lyrae stars with stable light curves. This was already noted by Preston (1964) for field variables. In this connection it is worthy to mention that according to results obtained by Balázs and Detre for RW Dra and RR Lyrae the greatest amplitude does not show variations with time, while the smallest amplitude may vary considerably. For some variables (var. 35, 44, 52) the observed greatest amplitude is considerably below expectation, probably because only smaller amplitudes have been observed at Budapest.

It is interesting to consider the variations of ε in course of a cycle of light curve changes. In Fig. 11 the extreme values are connected by a straight line.

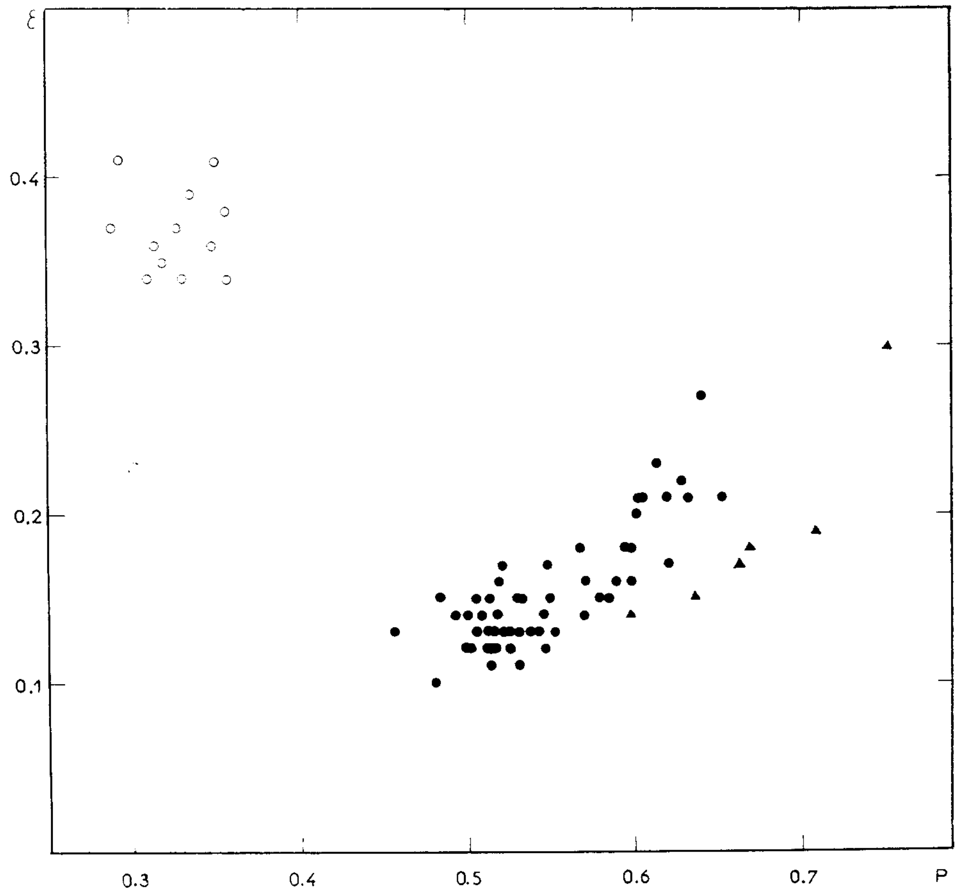


Figure 10.

Table 5

$P \pm 0^d.015$	n (all)	n_B (with Blasko-effect)	n_B/n
$0^d.29$	4	0	0.00
0.32	7	1	0.14
0.35	5	2	0.40
0.47	8	3	0.37
0.50	21	6	0.29
0.53	26	10	0.38
0.56	13	7	0.54
0.59	14	4	0.29
0.62	7	2	0.29
0.65	4	1	0.25
0.68	1	0	0.00
0.71	1	0	0.00
0.74	1	0	0.00
	112	36	

The ε-values change inside the region occupied by regular variables. This phenomenon strengthens the result obtained above that ε has a closer dependence on A than on P.

Among the 112 variables in M3 investigated in detail 36 (32%) show all the characteristics of the Blashko-effect as enumerated by Detre (1962). In Table 5 and in Fig. 13 the period-frequency is given for these stars. They have in M3 the highest frequency at P = 0^d47 and 0^d56, in good agreement with field RR Lyrae stars.

The period frequency distribution remains the same if we include also the 9 variables for which the presence of the Blashko-effect is not quite certain. No such statistics can be made for RRc stars.

The frequency of variables with Blashko-effect does not depend on the distance from the centre.

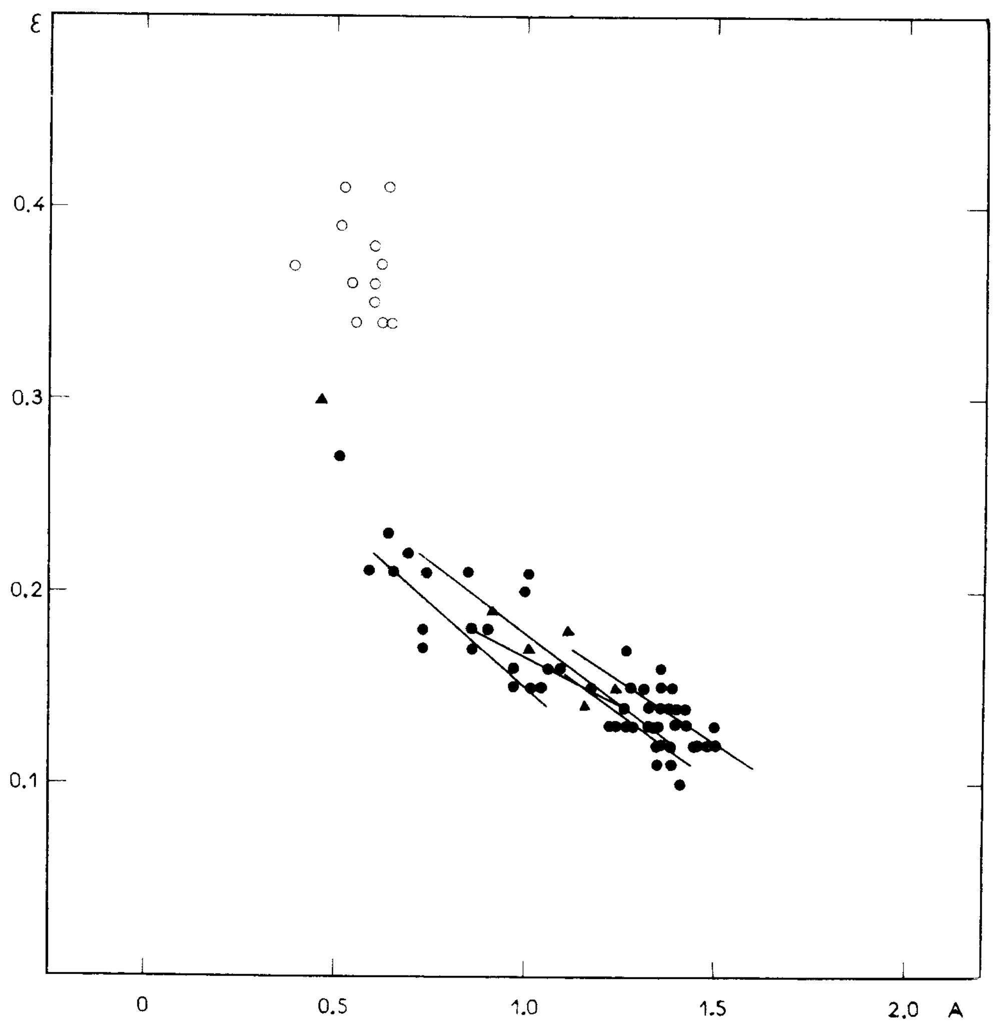


Figure 11.

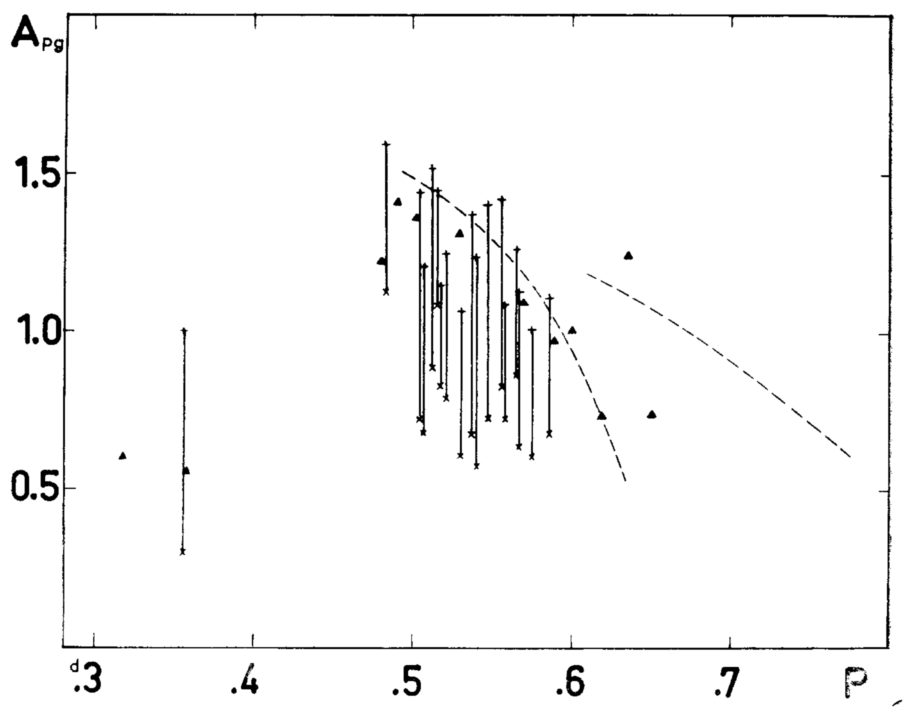


Figure 12.

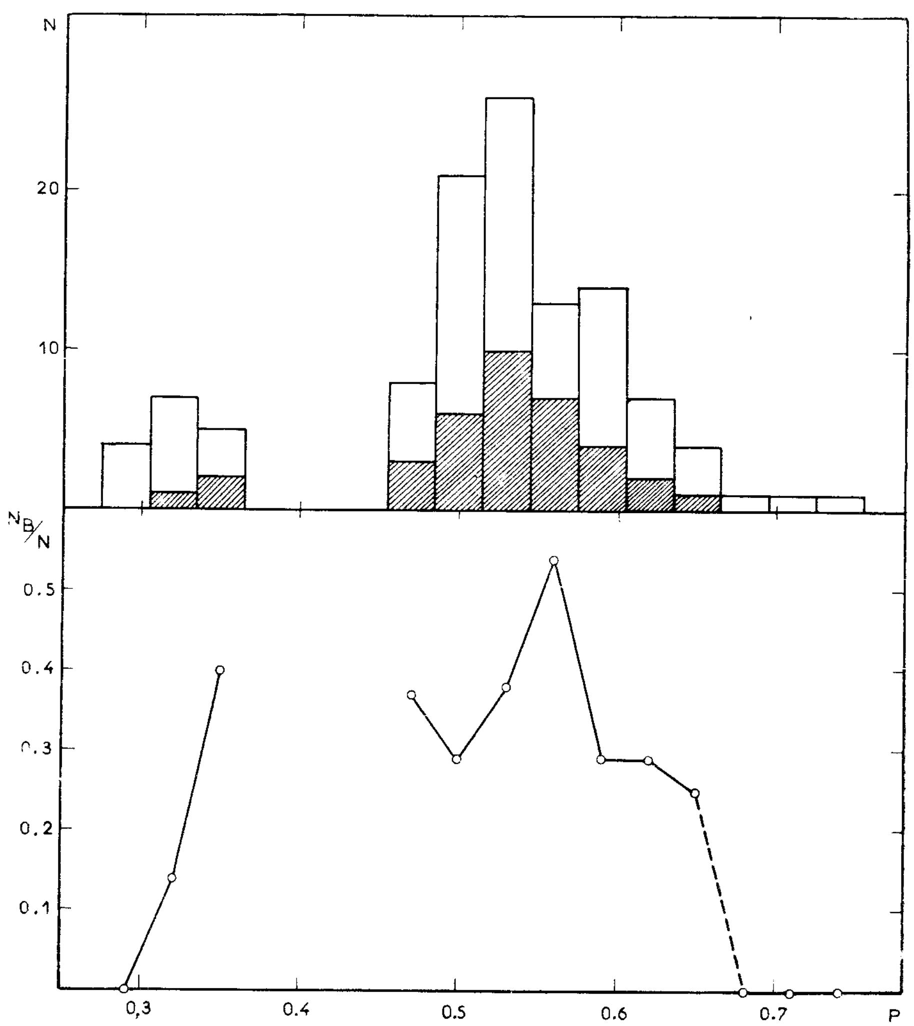


Figure 13.

COMPARISON WITH OTHER GLOBULAR CLUSTERS

Figure 7 shows the period-amplitude relation for ω Cen (Martin 1938) and M3. It contains only variables having stable light curves and situated at a distance 4′ or more from the centre in ω Cen and at 2′5 or more in M3, respectively.

The separation of RRab stars in two sequences, mentioned above for M3, can be well seen also for ω Cen (Belserene, 1954). The same phenomenon appears also for M5 (Oosterhoff, 1941) considering only regular stars having distances from the centre $r > 2'5$. The frequency distribution of the variables in both sequences is given in Table 6 (I: short period sequence; II: long period sequence).

Table 6.

Cluster	RRc	RRab I	RRab II	RR
M3	10 (20%)	35 (70%)	5 (10%)	50
M5	9 (29%)	16 (32%)	6 (19%)	31
ω Cen	43 (54%)	7 (9%)	30 (37%)	80

The relative population of the sequences differs markedly from cluster to cluster and seems to be correlated with the percentage of RRc stars. This statement is supported by NGC 320 (the data are taken from Sawyer's catalogue, 1955). In this cluster there is only one RRc star, while all the RRab stars with $r > 2'5$ belong to the short period sequence. The globular clusters can be apparently divided into two groups according to the population of the RRab sequences I and II. Between the two groups there is however no continuous transition (van Agt and Oosterhoff, 1959).

The short-period sequence I of the RRab stars in ω Cen as well as in M3, is perceptibly steeper than the long-period sequence II. In this way Detre's notes (1955) on the period-amplitude diagrams of globular clusters may be explained: the frequency of RRc stars increases with that of RRab stars, at the same time the average period of RRab stars becomes longer and the steepness of the combined I and II sequences decreases in the P—A diagram.

Another difference between the two sequences is in the average rate of change of the period (Belserene, 1954), i.e. in the average value of the coefficient β. The values of $10^{10}\,\beta$ for the clusters ω Cen, M5 and M3 are given in Table 7 (with their probable errors), further the number of variables used in the tabulation (in parentheses) and the number of stars with positive and negative

β-s, marked by + and − respectively. Table 7 contains for ω Cen the variables at distance 4′ or more from the centre, for M3 and M5 those situated at 2′5 or more from the centre.

Table 7

Cluster	$10^{10} \cdot \beta$ for RRab I stars	$10^{10} \cdot \bar{\beta}$ for RRab II stars: $P < 0^{d}7$	$P \geq 0^{d}7$	all
Cen	-3.86 ± 4.37 (7) 3 + and 4 −	$+1.34 \pm 3.60$ (15) 10 + and 5 −	$+10.94 \pm 3.04$ (11) 9 + and 1 −	$+5.40 \pm 2.58$ (26) 19 + and 6 −
M5	$+1.47 \pm 1.45$ (15) 9 + and 5 −	$+1.94 \pm 1.04$ (5) 4 + and 1 −	$+19.8$ (1) 1 + and 0 −	$+4.92 \pm 3.10$ (6) 5 + and 1 −
M3	$+0.21 \pm 1.42$ (26) 11 + and 9 −	0.00 ± 0.57 (3) 1 + and 1 −	$+2.3$ (1) 1 + and 0 −	$+0.58 \pm 0.70$ (4) 2 + and 1 −
The three clusters	$+0.01 \pm 1.10$ (48) 23 + and 18 −	$+1.30 \pm 2.48$ (23) 15 + and 7 −	$+10.96 \pm 2.75$ (13) 11 + and 1 −	$+4.78 \pm 1.98$ (36) 26 + and 8 −

Among the 13 RRab II stars with $P \geq 0^{d}7$ only one (var. 85 in ω Cen) has a negative β, with a small absolute value of $0.6 \cdot 10^{-10}$. On the long-period RRab sequence of M3 we have one star, var. 26, with a negative β. It has a period of 0.598, therefore, it cannot be clearly separated from sequence I, only its colour index B−V indicates its belonging to sequence II.

After all we can make the following statement: There is a pronounced period lengthening on the long period RRab branch, actually β increases with increasing period. On the short period branch positive and negative β values have the same frequency and we get $\beta = 0.0 \times 10^{-10}$. In this way it is understandable, that where sequence II is predominant (ω Cen), period lengthenings are prevailing, while positive and negative β values have the same frequency ($\beta \sim 0$) in clusters with predominant RRab I sequences (M3).

It is very probable, that the separation of the RRab stars into two sequences depends on chemical composition. That is suggested by Figure 7, where in addition to the P−A relation for ω Cen and M3 the same relation is shown for 50 field RR Lyrae stars. In this diagram open circles represent stars with $\Delta S = 0-2$ (normal metal content), solid circles stars with $\Delta S = 9-11$ (extremely low metal content). ΔS being Preston's index (Preston, 1959). The photoelectric B magnitudes were mainly taken from Kinman's paper (1961) and from unpublished Budapest observations. Apparently, stars with extremely low metal content occupy the long-period sequence II, whereas sequence I is the locus of stars with medium metal content. That is supported by the fact that the metal rich globular cluster NGC 6171 has a well populated sequence I (Kukarkin, 1961). It is worthy to note, that while M3 and ω Cen represent two extreme types of globular clusters with respect to the statistical properties of their RR Lyrae variables, both (even M5) belong to Morgan's class II containing clusters with weak metal lines. On the other hand NGC 6171 is of type VII−VIII, a cluster with strong metal lines (Sandage, Katem, 1964). We are led to the conclusion that RR Lyrae stars do not represent a chemically homogeneous group even within one and the same cluster. It is probable, that the two RRab sequences represent in the HRD the continuations of the two different branches of red stars on the horizontal branch (Arp, 1955). Perhaps the two branches represent stars evolving in opposite directions along the horizontal section of the HRD (Woolf, 1964).

REMARKS ABOUT INDIVIDUAL VARIABLES

Var 1 The O—C diagram can be well approximated by a negative parabolic curve. The star lies near the centre, therefore the brightness values are systematically higher. The O—C residuals have been computed with the ephemeris:

$$C = 242\,5000.260 + 0^{d}.5206250\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 384.442:	—22311	$-{}^{d}.154$:
	1896	13 691.627:	—21721	—.137:
	1900	15 160.870:	—18899	—.098:
L	1921	22 761.567	— 4300	—.005
M	1925	24 298.457	— 1348	—.000
G	1926	24 647.795	— 677	—.002
Ma	1940	29 770.197	+ 9162	—.029
Bp	1940	29 775.399	+ 9172	—.034:
	1941	30 078.401:	+ 9754	—.035:
	1950	33 390.572	+16116	—.081
	1952	34 121.516	+17520	—.094
	1953	34 487.510	+18223	—.099
RS	1953	34 507.815	+18262	—.099
Bp	1956	35 598.503	+20356	—.121
	1962	37 791.332:	+24569	—.164:

Var 5 Strongly changing light curve. There is an oscillation of about $0^{m}.7$ in the height of maxima. The depth of minima shows a variation of about $0^{m}.3$ amplitude as well. The periodic oscillations in the O—C residuals may exceed 2^{h}. In Larink and Martin's material no strong variations of the light curve are apparent. The O—C diagram drawn in the figure seems to be the most probable although it can not be determined unambiguously. The O—C residuals have been computed with the formula:

$$C = 2425000.326 + 0^{d}.5058940\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1900	J. D. 2415 161.836	—19448	$+{}^{d}.137$
H	1912	19 534.841	—10804	+.194
	1915	20 625.818:	— 8647	—.043:

Observer	Year	t max hel.	E	O—C
H	1915	J. D. 2420 654.771	−8590	+^{d}074
L	1921	22 760.458	−4427	—.275
M	1925	24 309.500	−1365	—.281
Sch	1938	28 966.781:	+7840	+.246:
Bp	1938	28 991.527	+7889	+.203
H	1939	29 430.736	+8757	+.296
Ma	1940	29 780.250	+9448	+.237
		29 781.260	+9450	+.236
Bp	1941	30 052.468	+9986	+.285
Be	1946	31 968.754	+13774	+.244
	1948	32 700.767:	+15221	+.228:
K	1952	34 131.313	+18049	+.107
RS	1953	34 483.905	+18746	+.090
Bp	1953	34 487.449	+18753	+.093
	1955	35 223.493	+20208	+.061
		35 224.473	+20210	+.029
K	1956	35 578.484	+20910	—.086
		35 614.496	+20981	+.008
Bp	1957	35 920.524	+21586	—.030
K	1959	36 668.553	+23065	—.218
		36 692.423	+23112	—.125
	1960	37 047.474	+23814	—.212

Var 6 The variable is of RRab type. The O—C diagram can be represented by a positive parabolic curve. It was computed with the ephemeris:

$$C = 2425000.271 + 0^{d}.5143228\ E.$$

Observer	Year	t max hel.	E	O—C
B	18[illegible]	J. D. 2413 390.519	—22573	+^{d}057
	1897	14 077.628:	—21237	+.030:
	1900	15 160.802	—19131	+.040
L	1921	22 760.407	— 4355	+.012
M	1925	24 289.479	— 1382	+.002
S	1926	24 621.730	— 736	+.001
Bp	1938	28 991.415	+7760	—.001
Ma	1940	29 770.106	+9274	+.005
Bp	1941	30 052.470:	+9823	+.006:
	1950	33 390.431:	+16313	+.012:
	1952	34 126.445	+17744	+.030
RS	1953	34 447.894:	+18369	+.027:
Bp	1953	34 488.532	+18448	+.034
	1955	35 223.505	+19877	+.040
	1956	35 600.511:	+20610	+.047:
	1960	37 018.513	+23367	+.061
	1962	37 791.545	+24870	+.066

Var 9 The cyclic oscillations superposed on the negative parabolic O—C curve may have some reality. The Budapest material is rather poor. The O—C residuals have been constructed using the formula:

$$C = 2425000.521 + 0^d_{\cdot}5415641\ E.$$

Observer	Year	t_{max} hel.	E	O−C
B	1895	J. D. 2413 372.533:	−21471	−$^d_{\cdot}$065:
	1896	13 691.528:	−20882	−.051:
	1897	14 140.508:	−20053	−.028:
	1900	15 160.804	−18169	−.039
H	1915	20 625.762	− 8078	−.004
L	1921	22 760.631	− 4136	+.019
M	1925	24 290.538	− 1311	−.008
S	1926	24 620.883	− 701	−.002
G	1926	24 683.707	− 585	+.001
H	1939	29 400.722	+ 8125	−.007
Ma	1940	29 770.070	+ 8807	−.006
Bp	1940	29 774.398:	+ 8815	−.011:
Be	1946	31 993.721	+12913	−.017
	1948	32 684.759	+14189	−.015
Bp	1950	33 422.349:	+15551	−.035:
	1951	33 763.542:	+16181	−.028:
	1952	34 121.507	+16842	−.037
RS	1953	34 483.809	+17511	−.041
Bp	1955	35 223.580	+18877	−.047
	1956	35 600.505	+19573	−.050
	1957	35 920.568	+20164	−.052
	1960	37 018.313:	+22191	−.057:
	1962	37 791.112:	+23618	−.070:

Var 10 There is an oscillation in the height of the light maxima amounting to 0^m2-0^m3, connected with variations in the slope of the rising branch. A positive parabola fits the O−C values well. The large scatter is probably an effect of the light curve changes. The residuals have been computed with the formula:

$$C = 2425000.247 + 0^d_{\cdot}5695185\ E.$$

Observer	Year	t_{max} hel.	E	O−C
B	1895	J. D. 2413 372.528:	−20417	+$^d_{\cdot}$140:
	1896	13 721.626:	−19804	+.123:
	1900	15 160.770	−17277	+.094
H	1912	19 479.939	− 9693	+.035
	1915	20 625.791	− 7681	+.016
L	1921	22 761.474	− 3931	+.004
M	1925	24 309.430	− 1213	+.009
G	1926	24 647.716	− 619	+.001
Bp	1938	28 991.449	+ 7008	+.016
H	1939	29 431.689	+ 7781	+.019
Ma	1940	29 770.559	+ 8376	+.025
Bp	1941	30 052.486	+ 8871	+.040
Be	1946	31 995.695	+12283	+.052
	1948	32 684.819:	+13493	+.059:
Bp	1951	33 763.500	+15387	+.072
	1952	34 118.323	+16010	+.085
	1953	34 487.374	+16658	+.088
RS	1953	34 507.864:	+16694	+.075:
Bp	1955	35 224.348:	+17952	+.105:

Observer	Year	t(med)hel.	E	O−C
Bp	1956	J. D. 2435 598.532	+18609	+^{d}.115
	1957	35 933.413	+19197	+.119
	1960	37 018.370:	+21102	+.144:
	1962	37 791.227:	+22459	+.164:

Var 11 In the interval covered by observations the period may be considered as constant. An extremely small decrease of the period is probable. The O—C values have been obtained with the formula:

$$C = 2425000.167 + 0^{d}.5078918\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1898	J. D. 2414 438.558:	−20795	+^{d}.001:
	1900	15 161.792	−19371	−.003
H	1912	19 479.891:	−10869	.000:
	1915	20 625.696	−8613	+.001
L	1921	22 733.447:	−4463	+.001:
M	1925	24 309.436	−1360	+.002
S	1926	24 620.773	−747	+.001
G	1926	24 683.753	−623	+.003
H	1939	29 408.668	+8680	.000
Ma	1940	29 770.287:	+9392	.000:
Bp	1940	29 775.363:	+9402	−.003:
Be	1948	32 684.568:	+15130	−.002:
Bp	1950	33 420.506	+16579	+.001
	1951	33 763.334:	+17254	+.002:
	1952	34 122.410	+17961	−.002
RS	1953	34 507.899:	+18720	−.002:
Bp	1955	35 224.535	+20131	.002
	1956	35 600.377	+20871	.000
	1957	35 933.551	+21527	−.003
	1960	37 018.413	+23663	+.002
	1962	37 791.423	+25185	+.001

Var 12 The star is of RRc type. The variation of the light curve can be clearly seen from differences in the shape and height of the maximum. The maxima are generally double (e.g. on J. D. 242 2761 and 243 5603). Missing strongly Martin and Belserene's material, the O—C diagram is rather uncertain. The residuals have been computed with the formula:

$$C = 2425000.063 + 0^{d}.3178890\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1985	J. D. 2413 372.508	−36577	−^{d}.129
	1896	13 691.636	−35573	−.162
	1897	14 077.479	−34359	−.236

Observer	Year	t(med)hel.	E	O—C
B	1898	J. D. 24 14 456.402:	—33167	—^{d}.237:
	1900	15 161.801	—30948	—.233
L	1921	22 761.576	— 7042	+.087
M	1925	24 288.401	— 2239	+.091
S	1926	24 642.838	— 1124	+.082
G	1926	24 647.933	— 1108	+.092
Bp	1938	28 991.384:	+12556	—.093:
Ma	1940	29 770.262	+15006	—.043
Bp	1940	29 774.377:	+15019	—.061:
	1941	30 078.330:	+15975	—.010:
	1950	33 420.511	+26488	+.204
	1951	33 763.521	+27567	+.212
	1952	34 120.527	+28690	+.229
	1953	34 487.370	+29844	+.228
RS	1953	34 507.700	+29908	+.213
Bp	1955	35 223.506	+32160	+.133
	1956	35 603.393	+33355	+.142
	1957	35 920.575:	+34353	+.071:
	1960	37 018.512:	+37807	+.020:
	1962	37 791.477	+40239	—.121

Var 13 It is an object very difficult to measure, lying in a very dense region near the centre. The star probably has a varying light curve. The cyclic oscillations superposed on the negative parabolic O—C curve may be real. The residuals have been computed with the formula:

$$C = 2425000.187 + 0^{d}\!.4830490\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 383.665:	—24048	—^{d}.160:
	1898	14 456.588:	—21827	—.088:
	1899	14 841.583:	—21030	—.083:
	1900	15 161.856	—20367	—.072
L	1921	22 756.426:	— 4645	+.002:
M	1925	24 309.423	— 1430	.004
G	1926	24 683.781	— 655	—.009
Bp	1940	29 719.565	+ 9770	—.010
Ma	1940	29 770.292	+ 9875	—.004
Bp	1941	30 078.464	+10513	—.017
	1952	34 121.536	+18883	—.065
RS	1953	34 483.815:	+19633	—.073:
Bp	1953	34 487.200:	+19640	—.069:
	1955	35 224.315:	+21166	—.087:
	1956	35 603.473	+21951	—.122
	1957	35 933.393:	+22634	—.125:
	1960	37 018.295:	+24880	—.151:

Var 14 The Budapest material does not show the great variations of the light curve suggested by Roberts and Sandage's measurements. The characteristics of the light curve are similar to those of RRab stars having periods

shorter by $0\overset{d}{.}1$ (The star belongs to the long period sequence). The O – C diagram has been constructed using the formula:

$$C = 2425000.315 + 0\overset{d}{.}6359019\ E.$$

Observer	Year	$t_{(\max)}$ hel.	E	O – C
B	1896	J. D. 2413 694.631:	−17779	−.016:
	1897	14 073.622:	−17183	−.009:
	1899	14 840.513:	−15977	+.003:
L	1921	22 760.661	− 3522	−.008
M	1925	24 285.559	− 1124	−.002
Bp	1938	28 991.259:	+ 6276	+.024:
Ma	1940	29 770.224	+ 7501	+.009
Bp	1940	29 775.314:	+ 7509	−.012:
	1950	33 390.410:	+13194	+.005:
	1952	34 118.517	+14339	−.005
	1953	34 487.348	+14919	−.013
RS	1953	34 507.694:	+14951	+.010:
Bp	1955	35 227.540	+16083	+.015
	1956	35 603.357:	+16674	+.014:
	1957	35 933.391	+17193	−.015
	1962	37 791.485	+20115	−.003

Var 15 The period increases but the residuals O – C can not be satisfactorily approximated by a parabola. The O – C values were computed with the formula:

$$C = 2425000.510 + 0\overset{d}{.}5300794\ E.$$

Observer	Year	$t_{(\max)}$ hel.	E	O – C
B	1895	J. D. 2413 377.510:	−21927	+.051:
	1899	14 840.512:	−19167	+.034:
	1900	15 161.744	−18561	+.038
L	1921	22 729.654	− 4284	+.004
M	1925	24 287.552	− 1345	−.001
S	1926	24 642.701	− 675	−.005
Bp	1938	28 991.492:	+ 7529	+.014:
Ma	1940	29 770.180	+ 8998	+.016
Bp	1940	29 774.417:	+ 9006	+.012:
	1950	33 422.444	+15888	+.032
	1952	34 120.561	+17205	+.035
	1953	34 487.377	+17897	+.036
	1956	35 598.432:	+19993	+.045:
	1957	35 933.444	+20625	+.046
	1960	37 018.517	+22672	+.047
	1962	37 791.382	+24130	+.056

Var 16 The star is a variable of type RRab. In the O – C diagram an abrupt change occurs at J. D. 242 9000. From J. D. 242 0000 to J. D. 242 9000 and from J. D. 242 9000 to J. D. 243 8000 the period can be considered as constant. The residuals have been computed utilizing the data:

$$C = 2425000.488 + 0^{d}.5115075\ E.$$

Observer	Year	t(med)hel.	E	O − C
B	1896	J. D. 2413 691.491:	−22109	−$0^{d}.078$:
	1897	14 067.457:	−21374	+.070:
H	1912	19 479.783:	−10793	−.005:
	1915	20 654.719	− 8496	−.001
L	1921	22 761.621	− 4377	−.001
M	1925	24 290.518	− 1388	+.002
S	1926	24 620.946	− 742	−.003
Bp	1938	28 991.268:	+ 7802	−.002:
H	1939	29 431.673	+ 8663	−.004
Ma	1940	29 770.288	+ 9325	−.007
Bp	1940	29 775.400	+ 9335	−.011
Be	1946	31 968.727	+13623	−.028
	1948	32 700.689	+15054	−.033
Bp	1950	33 422.424	+16465	−.035
RS	1953	34 482.768	+18538	−.046
Bp	1953	34 487.375	+18547	−.043
	1955	35 223.428	+19986	−.049
	1956	35 600.407	+20723	−.051
	1957	35 933.392	+21374	−.057
	1962	37 791.178:	+25006	−.067:

Var 17 The height of maximum-light oscillates between $15^{m}.2$ – $15^{m}.6$ This is connected with a strong variation of the whole light curve. (Variations of the same amplitude have been found by all other observers.) The residuals O – C belonging to the maxima do not show considerable oscillations, while Belserene found for the median point of the rising branch differences amounting to 1^{h}. The oscillations of the minima are even much greater. The large scatter in the O – C diagram is due to the Blashko-effect. The parabola drawn in the figure represents a rough approximation only. The residuals have been obtained with the formula:

$$C = 2425000.441 + 0^{d}.5761367\ E.$$

Observer	Year	t(med)hel.	E	O − C
B	1867	J. D. 2413 721.498	−19577	+$0^{d}.085$
	1897	14 077.531:	−18959	+.066:
	1899	14 841.461:	−17633	+.038:
	1900	15 161.801	−17077	+.046
H	1912	19 479.901	− 9582	+.002
	1915	20 654.651	− 7543	+.009
L	1921	22 761.599	3886	+.025
M	1925	24 289.491	1234	+.003
G	1926	24 647.846	− 612	−.001
		24 684.735	− 548	+.017
Sch	1938	28 964.850:	+ 6881	+.012:
Bp	1938	28 991.366:	+ 6927	−.026:
Ma	1940	29 770.302	+ 8279	+.025
Bp	1941	30 078.507	+ 8814	−.003
Be	1946	31 971.747	+12100	+.052
		31 994.743	+12140	+.002
	1948	32 683.812:	+13336	−.012:
Bp	1950	33 422.417	+14618	+.010
	1951	33 763.516	+15210	+.036

Observer	Year	t(med)hel.	E	O−C
Bp	1952	J. D. 2434 118.388	+15826	+^{d}008
		34 122.436:	+15833	+.023:
	1955	35 223.459	+17744	+.048
	1956	35 598.531	+18395	+.055
	1957	35 920.606:	+18954	+.070:
	1960	37 058.540:	+20929	+.134:
	1962	37 791.361	+22201	+.109

Var 18 The variation of the light curve is well pronounced. The residuals O−C for the minima are constant while the median point of the rising branch shows cyclic oscillations amounting to $0^{h}\!.5$. The height of the maxima varies with an amplitude of about $0^{m}\!.35$. The period is strongly variable. The section of the O−C diagram preceding Larink's observations is uncertain. The (O−C)-s were computed by the formula:

$$C = 2425000.066 + 0^{d}\!.5163623\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1896	J. D. 2413 692.597:	−21899	+^{d}349:
	1899	14 841.431:	−19674	+.277:
L	1921	22 756.490	− 4345	+.018
M	1925	24 288.524	− 1378	−.005
G	1926	24 647.907	− 682	.000
Sch	1938	28 966.752:	+ 7682	−.009
Bp	1938	28 991.532	+ 7730	−.015
H	1939	29 408.747	+ 8538	−.020
Ma	1940	29 770.186	+ 9238	−.035
Bp	1940	29 775.346:	+ 9248	−.039:
	1941	30 078.432	+ 9835	−.057
Be	1946	31 968.742	+13496	−.150
	1948	32 683.871	+14881	−.182
Bp	1952	34 121.375	+17665	−.231
RS	1953	34 447.723	+18297	−.224
Bp	1953	34 487.486	+18347	−.222
	1956	35 603.409	+20535	−.157
	1957	35 920.480	+21149	−.132
	1960	37 018.406:	+23275	+.007:
	1962	37 791.499	+24772	+.106

Var 19 The cyclic variation superposed on the negative parabola can be considered as real. The (O−C)-s were computed using the formula:

$$C = 2425000.319 + 0^{d}\!.6319796\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 372.520:	−18399	−^{d}006:
	1896	13 693.552:	−17891	−.020:
	1900	15 161.628:	−15568	−.033:

Observer	Year	t(med)hel.	E	O−C
L	1921	J. D. 2422 760.585	−3544	$+^{d}.002$
M	1925	24 287.438	−1128	−.008
G	1926	24 647.663:	−558	−.011:
Bp	1938	28 991.276:	+6315	+.006:
	1940	29 720.562:	+7469	−.013:
Ma	1940	29 770.512	+7548	+.011
Bp	1941	30 052.361:	+7994	−.003:
	1950	33 421.442	+13325	−.005
	1951	33 763.342:	+13866	−.006:
	1952	34 118.493	+14428	−.028
RS	1953	34 507.782	+15044	−.038
Bp	1955	35 224.459	+16178	−.026
	1956	35 600.511	+16773	−.002
	1957	35 933.561	+17300	−.005
	1960	37 018.628:	+19017	−.047:
	1962	37 791.554	+20240	−.032

Var 20 The variations of the light curve are conspicuous. The variations in the slope of the rising branch can be well seen on serial exposures taken by Martin on consecutive nights. This is supported by observations obtained at Budapest. Great variations in the height of maxima are very probable. According to Belserene the residuals O−C oscillate with an amplitude of about 1^{h}. The residuals have been calculated with the formula:

$$C = 2425000.248 + 0^{d}.4912570\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 078.534	−22232	$-^{d}108$
	1899	14 841.448:	−20679	−.096:
	1900	15 161.781	−20027	−.063
H	1912	19 479.934	−11237	−.059
L	1921	22 761.559	−4557	−.031
M	1925	24 289.396	−1447	−.003
		24 311.491	−1402	−.015
G	1926	24 684.836	−642	−.025
Ma	1940	29 770.374	+9710	+.021
Bp	1941	30 078.409:	+10337	+.037:
Be	1946	31 968.763	+14185	+.034
		31 995.747	+14240	−.001
	1948	32 700.715:	+15675	+.014:
Bp	1950	33 421.372:	+17142	−.003:
	1952	34 121.424	+18567	+.007
RS	1953	34 482.991	+19303	+.009
Bp	1953	34 487.414	+19312	+.011
	1956	35 603.480	+21584	−.059
	1957	35 933.603:	+22256	−.061:
	1960	37 058.621:	+24546	−.021:
	1962	37 791.550	+26038	−.048

Var 21 The O−C diagram deviates from a parabola, the rate of period increase is diminishing. The O−C curve was computed with the formula:

$$C = 2425000.268 + 0\overset{d}{.}5157286\ E.$$

Observer	Year	t(med)hel.	E	O − C
B	1897	J. D. 2414 067.561:	−21199	+0ᵈ224:
H	1912	19 479.960	−10704	+.051
	1915	20 654.781	− 8426	+.042
L	1921	22 761.504	− 4341	+.014
M	1925	24 286.500	− 1384	.000
Sch	1938	28 966.769:	+ 7691	+.032:
Bp	1938	28 991.522	+ 7739	+.030
H	1939	29 408.754	+ 8548	+.038
Ma	1940	29 770.288	+ 9249	+.046
Bp	1940	29 775.444	+ 9259	+.045
Be	1946	31 965.782	+13506	+.084
	1948	32 683.694	+14898	+.101
Bp	1950	33 422.236:	+16330	+.120:
	1952	34 120.549	+17684	+.136
	1953	34 487.244:	+18395	+.148:
RS	1953	34 507.871	+18435	+.146
Bp	1956	35 603.311	+20559	+.179
	1957	35 920.488	+21174	+.183
	1960	37 018.516	+23303	+.224
	1962	37 757.578:	+24736	+.247:

Var 22 The light curve varies with certainty, differences of $0^{m}1 - 0^{m}2$ can be revealed in the heights of maxima. The residuals O − C were computed with the formula:

$$C = 2425000.344 + 0\overset{d}{.}4814221\ E.$$

Observer	Year	t(med)hel	E	O − C
B	1895	J. D. 2413 377.494:	−24142	−0ᵈ358:
	1897	14 077.520:	−22688	−.319:
	1899	14 841.562:	−21101	−.294:
	1900	15 161.746	−20436	−.256
H	1912	19 479.726:	−11468	−.331:
	1915	20 656.835:	− 9023	−.363:
L	1921	22 761.563	− 4651	−.313
M	1925	24 313.496	− 1427	−.141
G	1926	24 683.630:	− 658	−.062:
H	1939	29 400.715	+ 9141	−.308
Ma	1940	29 770.440	+ 9909	−.316
Bp	1940	29 774.291:	+ 9917	−.316:
	1941	30 078.542:	+10549	−.324:
Be	1946	31 974.835:	+14488	−.352:
	1948	32 700.815:	+15996	−.357:
Bp	1950	33 422.466	+17495	−.358
	1951	33 763.289:	+18203	−.381:
	1952	34 121.494	+18947	−.355
RS	1953	34 447.876	+19625	−.377
Bp	1953	34 487.363	+19707	−.366
	1955	35 223.473	+21236	−.351
	1956	35 600.409	+22019	−.368
	1957	35 933.545	+22711	−.376
	1962	37 791.328	+26570	−.401

Var 23 I found variatons of the light curve with an oscillation of about $0^m1 - 0^m2$ in maximum(maxima on J.D. 243 4487 and J.D. 243 5224). The O−C diagram may be represented by a positive parabola as well. The high brightness values obtained for the variable suggest a close companion, but it can not be seen on Budapest plates. The (O−C)-s were computed using the formula:

$$C = 2425000.134 + 0^d5953756 \ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 140.492	−18240	$+^d009$
H	1915	20 656.849:	− 7295	−.020:
L	1921	22 761.526	− 3760	+.004
M	1925	24 312.469	− 1155	−.006
S	1926	24 620.882	− 637	+.002
G	1926	24 647.675:	− 592	+.003:
Bp	1938	28 991.544	+ 6704	+.012
	1939	29 346.375	+ 7300	−.001
H	1939	29 407.707	+ 7403	+.007
Ma	1940	29 770.317	+ 8012	+.034
Bp	1941	30 052.511	+ 8486	+.020
Be	1948	32 684.665	+12907	+.018
Bp	1950	33 422.348:	+14146	+.031:
	1951	33 763.498	+14719	+.031
	1952	34 118.345	+15315	+.034
	1953	34 487.462	+15935	+.018
	1955	35 224.548	+17173	+.029
	1956	35 600.239:	+17804	+.038:
	1957	35 920.541:	+18342	+.028:
	1960	37 018.417:	+20186	+.031:
	1962	37 791.222:	+21484	+.039:

Var 24 No hump can be seen on the rising branch. The variable has similar behaviour like RRab stars having shorter periods by about 0^d1 (on the lon g period sequence). Although the residuals O−C are represented by a straight line, smaller oscillations may be real. The (O−C)-s were computed with the formula:

$$C = 2425000.295 + 0^d6633494 \ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1896	J. D. 2413 691.522:	−17048	$+^d008$:
	1897	14 071.617:	−16475	+.003:
	1900	15 160.833	−14833	.000
L	1921	22 729.654	− 3423	+.004
M	1925	24 290.515	− 1070	+.004
S	1926	24 642.740	− 539	−.010
Ma	1940	29 770.450	+ 7191	+.009
Bp	1950	33 421.512	+12695	−.004
	1952	34 121.342:	+13750	−.007:
	1953	34 487.507	+14302	−.011
RS	1953	34 508.735	+14334	−.010
Bp	1955	35 224.493	+15413	−.006
	1956	35 603.275:	+15984	+.003:

Var 25 The O − C diagram suggests a varying light curve while the differences in the amplitudes obtained by different observers considering the $\Delta m_x - \Delta m_{Bp}$ relations may be negligible. Belserene's observations are well satisfied with the period $0^d.4799021$, while since Larink's observations the period $0^d.4800510$ can be considered as correct. Hence no doubt exists about an increase of the period by more than $0^d.0001 \approx 7^s$ between 1900 and 1921. The measuring of Mt. Wilson plates between 1912 to 1915 would be of prime importance. The star is a typical RRab variable, a rapid increase of brightness is followed by a slow decrease. The residuals were computed with the formula:

$$C = 2425000.336 + 0^d.4800510\ E.$$

Note: Between 1895 and 1900 the following ephemeris was used:

$$C = 2415160.729 + 0^d.4799021\ E.$$

Observer	Year	Max. hel.	E	O − C
B	1895	J. D. 2413 399.469:	−3670	$-0^d.019$:
	1896	13 721.508:	−2999	+.005:
	1897	14 079.515:	−2253	+.005:
	1898	14 437.522:	−1507	+.005:
	1900	15 160.729	0	.000
L	1921	22 760.428	−4666	+.010
M	1925	24 311.465	−1435	+.002
S	1926	24 642.700	−745	+.002
Ma	1940	29 770.119	+9936	−.004
Bp	1940	29 775.396	+9947	−.007
	1941	30 052.394:	+10524	+.001:
	1950	33 420.447	+17540	+.016
	1952	34 118.442	+18994	+.017
RS	1953	34 483.762	+19755	+.018
Bp	1955	35 224.489	+21298	+.027
	1956	35 600.372	+22081	+.030
	1957	35 920.568	+22748	+.032
	1960	37 018.460	+25035	+.047

Var 26 A hump can be suggested in the rising branch. In the O − C diagram a negative parabola was drawn but it can not be considered as real with certainty. In spite of its long period the star has a rather large amplitude. According to the (B − V)-period relation (Figure 9) the star belongs to the long period sequence. The (O − C)-s were computed with the data:

$$C = 2425000.571 + 0^d.5977452\ E.$$

Observer	Year	Max. hel.	E	O − C
B	1895	J. D. 2413 384.549:	−19433	$-0^d.040$:
	1897	14 078.564	−18272	−.007:
	1899	14 839.472:	−16999	−.028:
L	1921	22 761.412	−3746	−.005

Observer	Year	t(med)hel.	E	O – C
M	1925	J. D. 2424 290.450	− 1188	.000
G	1926	24 683.767	530	.001
Ma	1940	29 770.586	+ 7980	.008
Bp	1941	30 078.415	+ 8495	.001
	1950	33 390.517	+14036	.006
	1951	33 763.504	+14660	−.012
	1952	34 121.561	+15259	.004
RS	1953	34 483.783	+15865	.016
Bp	1953	34 487.375	+15871	.010
	1955	35 224.395:	+17104	−.010:
	1956	35 600.374	+17733	.013

Var 27 Larink's observations suggest varying light curve. Strong variations in the ascending branch and not very large differences in the height of maxima can be detected, but the oscillations in the residuals O – C for the maxima may be considerable (J. D. 242 2730; 756; 760; 840). Budapest observations in 1941 seem to confirm variations of the same character (J. D. 243 0052; 078). The material of other observers is unfortunately insufficient to decide this question with certainty. The negative parabola seems to be a good fitting of the residuals O – C for the interval following J. D. 2426000. The residuals were computed utilizing the formula:

$$C = 2425000.502 + 0^d5790912\ E.$$

Observer	Year	t(med)hel.	E	O – C
B	1896	J. D. 2413 664.671:	−19575	+.121:
	1900	15 161.695:	−16990	−.048:
L	1921	22 756.535	− 3875	−.011
M	1925	24 290.540	− 1226	−.004
S	1926	24 565.027	752	−.002
G	1926	24 683.739	547	.000
Bp	1940	29 719.515:	+ 8149	−.001:
Ma	1940	29 770.471	+ 8237	−.005
Bp	1941	30 078.547	+ 8769	−.006
	1950	33 420.451	+14530	−.037
	1951	33 763.268:	+15132	−.042:
	1952	34 120.563	+15749	−.046
RS	1953	34 447.741	+16314	−.055
Bp	1955	35 224.307:	+17655	−.050:
	1962	37 791.350	+22088	−.118

Var 28 The observational material indicates a strongly varying light curve. This is shown also by our material, although the scatter is considerable, as the star is close to the centre. Because of the large scatter a mean curve is published. The observations of the year 1962 have been omitted. Larink's observations show a large scatter, but in spite of that, differences of about 0^m6 can be found in the height of maximum light. Larink's epoch is quite uncertain. Larink and Martin's material shows clearly oscillations in O – C caused by the variations of the light curve. The O – C diagram has cycles of great amplitude.

The interval before Larink can not be fitted by a curve. The Mt. Wilson material of 1912 and 1915 is extremely needed. The O—C values have been calculated by the formula:

$$C = 2425000.411 + 0^{d}_{.}4706364\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 377.482:	—24696	—^{d}.092:
	1900	15 160.750	—20907	—.066
L	1921	22 730.475:	— 4823	—.057:
M	1925	24 287.466	— 1515	+.069
G	1926	24 684.710	— 671	+.096
Bp	1938	28 991.365:	+ 8480	—.043:
Ma	1940	29 770.241	+10135	—.070
Bp	1940	29 775.420	+10146	—.068
	1941	30 078.475	+10790	—.103
	1950	33 390.536	+17827	+.090
	1952	34 121.417	+19380	+.073
	1953	34 488.527	+20160	+.086
RS	1953	34 508.759	+20203	+.081
Bp	1955	35 224.572	+21724	+.056
	1956	35 603.406	+22529	+.028
	1957	35 920.586	+23203	—.001
	1960	37 018.602	+25536	+.020
	1962	37 791.342	+27178	—.025

Var 31 The star is a difficult object lying close to the centre. This fact gives rise to errors exceeding the average. The O—C values were computed with the formula:

$$C = 2425000.034 + 0^{d}_{.}5807216\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 691.617:	—19473	—^{d}.025:
	1897	14 079.550:	—18805	—.014:
	1900	15 160.859:	—16943	—.009:
L	1921	22 733.476	— 3903	—.002
M	1925	24 312.451	— 1184	—.009
G	1926	24 684.701	— 543	—.001
Bp	1940	29 719.545	+ 8127	—.013
Ma	1940	29 770.073	+ 8214	—.008
Bp	1941	30 078.433	+ 8745	—.011
	1950	33 420.486	+14500	—.011
	1952	34 121.407	+15707	—.021
	1953	34 487.260:	+16337	—.023:
	1956	35 603.405	+18259	—.025
	1957	35 920.488:	+18805	—.016:
	1960	37 018.630	+20696	—.018
	1962	37 791.574	+22027	—.015

Var 32 The star lies in a dense region near the centre, therefore the errors exceed the average and the brightness data are systematically higher. Variations of the light curve are possible, but because of the large scatter their reality

cannot be assured. The uncertainty of epochs is considerable as well. This uncertainty can be also responsible for the large scatter in the O−C diagram. The (O−C)-s were computed using the formula:

$$C = 2425000.450 + 0^{d}.4953518\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 377.506:	−23464	$-{}^{d}.009$:
	1896	13 691.530:	−22830	−.038:
	1898	14 437.551:	−21324	−.017:
	1900	15 161.759	−19862	−.014
L	1921	22 760.477	− 4522	.008
M	1925	24 309.432	− 1395	−.002
G	1926	24 647.751	− 712	−.009
Ma	1940	29 770.180	+ 9629	−.012
Bp	1941	30 078.303:	+10251	.002:
	1950	33 421.418	+17000	−.013
	1952	34 118.380:	+18407	−.011:
	1953	34 487.418	+19152	−.010
	1955	35 223.502	+20638	−.018
	1956	35 603.438	+21405	−.017
	1957	35 920.472:	+22045	−.008:
	1960	36 991.397:	+24207	−.034:
	1962	37 791.412:	+25822	−.012:

Var 33 The variation of the light curve is clearly seen from the differences in the slope of the ascending branch and in the height of the maximum. The material is insufficient to decide the reality of the oscillations in the O−C diagram. The scatter in the O−C diagram is probable the consequence of the Blashko-effect. The residuals were computed with the formula:

$$C = 2425000.440 + 0^{d}.5252237\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 383.503:	−22118	$-{}^{d}.039$:
	1897	14 080.483:	−20791	−.031:
	1898	14 456.544:	−20075	−.030:
	1899	14 841.529:	−19342	−.034:
L	1921	22 761.445	− 4263	.034
M	1925	24 292.456	− 1348	.018
G	1926	24 683.701	− 603	−.029
Bp	1940	29 719.553	+ 8985	−.022
Ma	1940	29 770.503	+ 9082	−.019
Bp	1950	33 422.413	+16035	.011
	1952	34 121.451	+17366	−.024
	1953	34 487.514	+18063	−.042
	1955	35 227.574	+19472	−.022
	1956	35 600.473	+20182	−.032
	1957	35 933.460	+20816	−.037
	1960	37 018.560	+22882	−.049
	1962	37 757.580:	+24289	−.018:

Var 34 The light curve varies. The differences in the height of maximum amounts — according to Budapest observations — to 0^m4. The time oscillation of the maximum amounts in Greenstein's material at least to 0^h7. The O—C diagram is rather complicated. The residuals were computed by the formula:

$$C = 2425000.498 + 0^d5591012\ E.$$

Observer	Year	tomed hel.	E	O—C
B	1895	J. D. 2413 383.495:	−20778	$+0^d002$:
	1896	13 691.557:	−20227	−.001:
	1897	14 079.574	−19533	.000
	1899	14 840.501:	−18172	−.010:
	1900	15 160.893	−17599	+.017
L	1921	22 733.491	− 4055	+.148
M	1925	24 313.496	− 1229	+.133
G	1926	24 647.774	− 631	+.069
		24 684.704	− 565	+.098
Bp	1938	28 991.390	+ 7138	+.028
	1939	29 346.375	+ 7773	−.017
Ma	1940	29 770.192:	+ 8531	+.002:
Bp	1950	33 421.524	+15062	−.156
	1952	34 121.529	+16314	−.146
RS	1953	34 483.773	+16962	−.200
Bp	1955	35 223.563	+18285	−.100
	1956	35 600.507	+18959	+.007
	1960	37 057.513:	+21565	−.002:
	1962	37 757.552:	+22817	+.042:

Var 35 The light curve varies considerably. The differences in the height of maximum exceed 0^m5 and in the O—C values 2^h, respectively. The O—C of the maxima show the smallest oscillation — about 1^h — according to Kukarkin's observations. It can be expected — also on the ground of the period-amplitude diagram — that the brightness of highest maximum exceeds 15^m04, observed in Budapest. The pronounced decrease of the period lasted till J. D. 2430000. As the secondary period can not be determined, the time-oscillations arising from the beat phenomena can not be eliminated in the O—C diagram. Therefore the large scatter in the O—C values. The residuals were calculated by the formula:

$$C = 2425000.038 + 0^d5306059\ E.$$

Observer	Year	tomed hel.	E	O—C
B	1895	J. D. 2413 378.471:	−21901	-0^d767:
	1896	13 691.585:	−21311	−.711:
	1897	14 071.601	−20595	−.608
	1898	14 456.359:	−19870	−.540:
	1899	14 839.481	−19148	−.515
	1900	15 161.612:	−18541	−.462:
H	1915	20 654.817	− 8189	−.089
L	1921	22 756.615	− 4228	−.021
M	1925	24 289.550	− 1339	−.007

Observer	Year	[illegible]	E	O − C
S	1926	J. D. 2424 621.703	−713	$-0^{d}.013$
G	1926	24 647.716	−664	.000
H	1939	29 400.714	+8294	−.169
		29 408.706	+8309	−.136
Ma	1940	29 770.01:	+8990	−.175:
Be	1946	31 971.780	+13140	−.420
	1948	32 683.828	+14482	−.445
		32 700.719	+14514	−.533
Bp	1950	33 390.545	+15814	−.495
		33 422.438	+15874	−.438
	1952	34 121.555	+17192	−.660
K	1953	34 455.368	+17821	−.598
RS	1953	34 482.999	+17873	−.558
Bp	1956	35 600.370	+19979	−.643
K	1956	35 601.399	+19981	−.675
Bp	1957	35 933.543	+20607	−.691
K	1959	36 661.460	+21979	−.765
		36 692.306	+22037	−.694
Bp	1960	36 991.449	+22601	−.813
		37 018.584	+22652	−.739
K	1960	37 024.376	+22663	−.784
Bp	1962	37 791.542	+24109	−.874

Var 36 The variable has in relation to its period an unusually great amplitude and steep ascending branch. The large cycles superposed on the positive parabola are real. The (O − C)-s were computed by the formula:

$$C = 2425000.018 + 0^{d}.5455855\ E.$$

Observer	Year	[illegible]	E	O − C
B	1895	J. D. 2413 372.520	21312	$+0^{d}.020$
H	1912	19 534.900	10017	+.012
	1915	20 625.527:	−8018	+.014:
L	1921	22 761.494	−4103	+.013
M	1925	24 311.497	−1262	+.008
G	1926	24 684.679:	−578	+.009:
Bp	1938	28 991.511	+7316	−.011
H	1939	29 430.704	+8121	−.014
Ma	1940	29 770.063	+8743	−.009
Bp	1940	29 774.427:	+8751	.010:
	1941	30 078.318:	+9308	−.010:
Be	1946	31 968.783	+12773	+.001
	1948	32 684.585	+14085	−.005:
Bp	1950	33 390.587	+15379	+.010
	1952	34 120.589	+16717	+.018
	1955	35 227.591	+18746	+.027
	1956	35 603.501	+19435	+.029
	1957	35 933.582	+20040	+.031
	1960	36 991.486	+21979	+.044
	1962	37 791.322:	+23445	+.052:

Var 37 The star is a variable of RRc type. The negative parabola represents a rather good approximation for the residuals O—C, but different oscillations may be present around it. The residuals were computed with the formula:

$$C = 2425000.015 + 0^{d}\!.3266390\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 077.515:	—33439	—^{d}.018:
	1899	14 841.516:	—31100	—.026:
H	1912	19 479.806:	—16900	—.010:
	1915	20 625.655	—13392	—.011
L	1921	22 761.553	— 6853	—.005
M	1925	24 311.460	— 2108	.000
S	1926	24 620.787	— 1161	.000
G	1926	24 683.828	— 968	.000
Bp	1938	28 991.534:	+12220	—.010:
	1939	29 408.645	+13497	—.017
Ma	1940	29 770.244	+14604	—.007
Bp	1941	30 052.465	+15468	—.002
Be	1946	31 969.821	+21338	—.017
	1948	32 683.853	+23524	—.018
Bp	1950	33 421.400	+25782	—.022
	1951	33 763.394	+26829	—.019
	1952	34 118.440	+27916	—.029
RS	1953	34 482.966	+29032	—.032
Bp	1953	34 488.519	+29049	—.032
	1955	35 223.452	+31299	—.037
	1956	35 600.413	+32453	—.017
	1957	35 933.579:	+33473	—.023:
	1960	37 057.539	+36914	—.028
	1962	37 791.493	+39161	—.032

Var 38 There is a strong variation in the light curve of the star. The differences in the height of the maxima may exceed $0^{m}\!.6$. Also variations in the brightness of the minima are probable. Unfortunately no well observed minimum is available. Kukarkin's observations show oscillations of the O—C values amounting to $0^{h}\!.8$, while Müller's observations give not less than $1^{h}\!.3$ for the amplitude of the time shift of the maxima. Considerable variations can be observed also in the slope of the rising branch.

$$C = 2425000.093 + 0^{d}\!.5580276\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 691.581:	—20265	—^{d}.083:
	1899	14 839.459:	—18208	—.067:
H	1915	20 625.693	— 7839	—.022
		20 626.806	— 7837	—.025
		20 654.736	— 7787	+.004
M	1925	24 287.465	— 1277	—.027
		24 311.515	— 1234	+.028
S	1926	24 621.750	— 678	.000
G	1926	24 647.948	— 631	—.030

Observer	Year	t(med)hel.	E	O−C
G	1926	J. D. 2424 683.683	−567	$-.^{d}008$
		24 684.808	−565	+.001
Sch	1938	28 964.843:	+7104	−.036:
H	1939	29 367.764:	+7827	−.011:
Ma	1940	29 770.093:	+8548	−.020:
Bp	1941	30 052.466	+9054	−.009
Be	1946	31 968.696	+12488	−.046
Bp	1950	33 390.575	+15036	−.021
	1952	34 121.546	+16346	−.066
RS	1953	34 483.698	+16995	−.074
		34 507.730	+17038	−.037
K	1955	35 226.456:	+18326	−.051:
Bp	1955	35 227.570	+18328	−.053
K	1956	35 601.446	+18998	−.055
		35 606.465	+19007	−.059
		35 614.293	+19021	−.043
		35 615.406	+19023	−.046
Bp	1957	35 933.459	+19593	−.069
K	1959	36 658.331	+20892	−.075
		36 669.480	+20912	−.086
		36 687.313	+20944	−.110
		36 692.361	+20953	−.084
Bp	1960	36 991.431:	+21489	−.117:
K	1960	37 024.386	+21548	−.086

Var 39 The star has a considerably varying light curve, with differences in the height of maxima amounting to at least $0^{m}.4$. The oscillations in the O − C values exceed $0^{h}.4$ (Belserene J. D. 2431968;995). The differences in the depth of the minimum are blurred by the scatter, but apparently low minima are followed by high maxima. The low maxima seem to be double, or the brightness remains constant for a time interval (J. D. 2415160; J. D. 2422761; J. D. 2433763; J. D. 2434121; J. D. 2435223). The scatter resulting from the variations of the light curve is not eliminated in the O − C diagram. The period is approximately constant. The O − C diagram was constructed using the formula:

$$C = 2425000.106 + 0^{d}.5870766\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 372.492:	−19806	$+.^{d}025$:
	1987	14 077.576:	−18605	+.025:
	1900	15 160.733	−16760	+.031
H	1912	19 479.862:	−9403	+.037:
	1915	20 625.843:	−7451	+.045:
L	1921	22 761.564	−3813	−.019
M	1925	24 311.459	−1173	−.006
S	1926	24 620.848	−646	−.007
G	1926	24 684.823	−537	−.023
Ma	1940	29 770.160	+8125	+.057
Bp	1940	29 775.422	+8134	+.035
	1941	30 052.512:	+8606	+.025:

Observer	Year	t(med)hel.	E	O−C
Be	1946	J. D. 2431 968.704	+11870	−$^{\mathrm{d}}$.001
		31 995.726	+11916	+.015
	1948	32 683.800	+13088	+.035
Bp	1951	33 763.437	+14927	+.039
	1952	34 121 527	+15537	+.012
RS	1953	34 483.781	+16154	+.040
Bp	1955	35 223.466	+17414	+.008
	1956	35 600.352:	+18056	−.009:
	1960	37 057.532:	+20538	+.047:
	1962	37 791.333:	+21788	+.002:

Var 40 The hump in the ascending branch is well pronounced. The period is nearly constant. The residuals were computed with the ephemeris:

$$C = 2425000.091 + 0^{d}5515411\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 383.525:	−21062	−$^{\mathrm{d}}$.007:
	1897	14 074.612	−19809	−.001
	1900	15 161.702:	−17838	+.001:
H	1915	20 625.814	− 7931	−.005
L	1921	22 730.498	− 4115	−.001
M	1925	24 292.464	− 1283	.000
S	1926	24 642.692	− 648	.000
G	1926	24 647.659:	− 639	+.003:
Bp	1938	28 963.467:	+ 7186	+.002:
H	1939	29 431.726	+ 8035	+.002
Ma	1940	29 770.374	+ 8649	+.004
Bp	1940	29 775.338:	+ 8658	+.004:
Be	1946	31 978.195	+12652	+.006
	1948	32 687.475	+13938	+.004
Bp	1950	33 420.471	+15267	+.002
	1951	33 763.527	+15889	−.001
	1952	34 121.480	+16538	+.002
RS	1953	34 482.735	+17193	−.002
Bp	1955	35 224.560	+18538	.000
	1956	35 603.466	+19225	−.003
	1962	37 791.432	+23192	.000

Var 41 The star lies in a dense region near the centre, therefore the scatter is considerable, the mean curve distorted and the brightness data are uncertain. Bailey's observations are rather uncertain and the epochs derived are very inaccurate. Missing the Mt. Wilson material of 1912 and 1915, the O−C diagram before Larink's observations is not reliable at all. The light curve probably varies, as suggested especially by Larink's maxima, by Müller's flat ascending branches and the complexity of the O−C diagram. Because of the large scatter it is impossible to establish the variation of the light curve with certainty. The residuals have been calculated with the formula:

$$C = 2425000.391 + 0^{\mathrm{d}}.4850462\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 383.504:	23950	$^{\mathrm{d}}$.031:
	1897	14 077.548:	−22519	−.088:
	1899	14 841.565:	20944	.018:
L	1921	22 761.518	4616	−.100
M	1925	24 287.409	1470	+.036
G	1926	24 647.793	727	−.031
Ma	1940	29 770.198	+ 9834	−.137
Bp	1952	34 118.687:	+18799	−.088:
	1953	34 487.332:	+19559	−.078:
	1955	35 227.516	+21085	−.074
	1956	35 603.434	+21860	.067
	1960	37 018.361:	+24777	−.020:
	1962	37 791.555	+26371	−.011

Var 42 The star is a difficult object lying near the centre. Therefore, the scatter is considerable and the brightness data systematically higher. In consequence of the considerable observational errors the light curve variation can not be established with certainty, although the complexity of the O−C diagram shows the existence of such variations. The period shows an unusually strong decrease. The residuals were calculated with the formula:

$$C = 2425000.055 + 0^{\mathrm{d}}.5901852\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 389.525:	−19672	−0$^{\mathrm{d}}$.406:
	1899	14 841.460:	17212	−.327:
	1900	15 160.763	−16671	−.315
L	1921	22 761.476	− 3793	−.006
M	1925	24 312.486	1165	.003
S	1926	24 621.746	641	.000
G	1926	24 647.715	597	−.001
Bp	1938	28 991.411	+ 6763	.067
Ma	1940	29 770.443	+ 8083	−.079
Bp	1941	30 078.504	+ 8605	−.095
	1950	33 390.497:	+14217	−.221:
	1951	33 763.484	+14849	−.231
	1952	34 120.525	+15454	−.252
	1955	35 223.516	+17323	−.317
	1957	35 933.467	+18526	−.359
	1962	37 791.245:	+21674	−.484:

Var 43 The star is near the centre and has a close companion, therefore the scatter is considerable. The light curve is strongly variable, the maxima indicate differences amounting to $0^{\mathrm{m}}.6$ – $0^{\mathrm{m}}.7$. Before J. D. 2433000 the observations are satisfied by the period $0^{\mathrm{d}}.5405$, afterwards by $0^{\mathrm{d}}.5403$. The author had the opportunity to estimate the brightness of the star on Moscow plates. Basing on these estimates the following O−C values have been obtained: for 1953

O—C = $+0^{d}320$, for 1959 O—C = $-0^{d}07$, for 1960 the O—C lies within the interval ($-0^{d}45$; $-0^{d}36$) or within ($-0^{d}09$; $-0^{d}18$). Budapest material provides the O—C interval ($-0^{d}172$; $-0^{d}372$) for 1960. The O—C diagram is of complicated structure. The curve drawn in Fig. 40 seems to be the most probable one, but the point for 1962 should be perhaps shifted by 1P downwards. The (O—C)-s were computed with the formula:

$$C = 2425000.441 + 0^{d}5404790\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 384.502:	−21491	−^{d}505:
	1896	13 692.561:	−20921	−.519:
	1897	14 079.583:	−20205	−.480:
	1900	15 161.695:	−18203	−.407:
L	1921	22 760.639	− 4144	−.057
M	1925	24 292.404	− 1310	−.010
G	1926	24 683.715	− 586	−.005
Bp	1938	28 991.502:	+ 7384	+.164:
Ma	1940	29 770.382	+ 8825	+.214
Bp	1941	30 078.469	+ 9395	+.228
	1950	33 421.445	+15580	+.341
	1952	34 122.427	+16877	+.322
	1956	35 600.497	+19612	+.182
	1962	37 791.561	+23667	−.396

Var 44 The star has a varying light curve, the maxima indicating differences of $0^{m}6$. The O—C shows a complex structure with sudden variations. It is difficult to decide wether the scatter in the diagram is the consequence of accidental variations in the period or that of the variations of the light curve. The O—C diagram was constructed using the ephemeris:

$$C = 2425000.080 + 0^{d}5063961\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 372.501:	−22962	−^{d}288:
	1896	13 664.683:	−22385	−.280:
	1899	14 841.554	−20061	−.286
H	1912	19 479.966	−10901	−.110
	1915	20 625.754	− 8638	−.076
L	1921	22 756.566	− 4430	−.179
M	1925	24 284.525	− 1413	−.017
Bp	1938	28 991.535	+ 7882	−.041
H	1939	29 400.716	+ 8690	−.054
		29 431.622	+ 8751	−.070
Bp	1940	29 775.443	+ 9430	−.048
	1941	30 052.442:	+ 9977	−.048:
Be	1946	31 973.700	+13771	−.039
	1948	32 683.697	+15173	−.069
Bp	1950	33 420.521	+16628	−.087
	1952	34 118.358	+18006	−.110
RS	1953	34 482.934	+18726	−.081
Bp	1953	34 487.485:	+18735	−.074:
	1960	37 018.447:	+23733	+.068:

Var 45 The Budapest material is rather poor. According to Larink's (J. D. 2422729; 756) and Belserene's observations light curve variation may occur. The residuals were computed with the formula:

$$C = 2425000.110 + 0\overset{d}{.}5368966\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 372.573:	−21657	$+\overset{d}{.}033$:
	1896	13 692.543:	−21061	+.012:
	1897	14 071.597	−20355	+.017
	1898	14 456.553	−19638	+.018
	1899	14 841.469:	−18921	−.020:
H	1912	19 479.224:	−10283	+.022:
	1915	20 656.594:	− 8090	−.023:
L	1921	22 729.553	− 4229	−.021
M	1925	24 291.402	− 1320	−.004
G	1926	24 647.905	− 656	−.001
H	1939	29 431.648	+ 8254	−.007
Ma	1940	29 770.427	+ 8885	−.009
Bp	1940	29 775.257:	+ 8894	−.011:
	1941	30 052.295:	+ 9410	−.012:
Be	1946	31 993.719	+13026	−.006
	1948	32 684.705:	+14313	−.006:
Bp	1950	33 422.414	+15687	+.007
	1951	33 763.337:	+16322	+.001:
	1952	34 121.454	+16989	+.008
RS	1953	34 482.767	+17662	−.011
Bp	1955	35 227.461:	+19049	+.008:
	1956	35 603.286:	+19749	+.006:
	1957	35 933.476	+20364	+.004
	1960	37 018.544	+22385	+.004

Var 46 The star is near the centre, therefore the brightness data are systematically higher. Unfortunately no observations were obtained since 1955 in the ascending branch or maximum. The (O−C)-s were calculated with the formula:

$$C = 2425000.434 + 0\overset{d}{.}6133669\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 077.636:	−17808	$+\overset{d}{.}040$:
	1899	14 839.464:	−16566	+.066:
	1900	15 160.834:	−16042	+.032:
L	1921	22 761.024	− 3651	−.007
M	1925	24 286.496	− 1164	+.021
		24 291.381	− 1156	−.001
G	1926	24 647.746	− 575	−.002
Ma	1940	29 770.608	+ 7777	+.020
Bp	1941	30 078.504	+ 8279	+.005
	1950	33 421.377	+13729	+.029
	1952	34 121.235:	+14870	+.035:
RS	1953	34 483.743	+15461	+.043
Bp	1953	34 487.426	+15467	+.046
	1955	35 223.463	+16667	+.043

Var 47 The light curve is subjected to strong variations, the maxima indicate differences amounting to $0^m_.7$. Unfortunately the star was not measured by Hett, Belserene, Roberts and Sandage, therefore, the O—C diagram is rather uncertain. As the star lies in a dense region, the brightness values measured in the minima are systematically too high. The normal points do not give the true shape of the maxima. The residuals were computed with the formula:

$$C = 2425000.456 + 0^d_.5409923\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 691.501:	—20904	—$^d_.$052:
	1897	14 067.536:	—20209	—.007:
	1898	14 456.532:	—19490	+.016:
L	1921	22 756.394:	— 4148	—.026:
M	1925	24 287.395	— 1318	—.033
S	1926	24 621.722	— 700	—.039
G	1926	24 647.696	— 652	—.033
Bp	1938	28 991.381:	+ 7377	+.025:
Ma	1940	29 770.435	+ 8817	+.050
Bp	1950	33 420.462	+15564	+.002
	1951	33 763.429	+16198	—.020
	1952	34 121.538	+16860	—.048
	1955	35 223.547	+18897	—.040
	1960	37 018.558	+22215	—.042
	1962	37 757.586:	+23581	—.009:

Var 48 Light curve changes are possible, e.g. the slopes of the ascending branches on J. D. 2434118 and J. D. 2435223 respectively, are different. This may be the cause of the scatter around the positive parabola in the O—C diagram. The diagram was constructed using the ephemeris:

$$C = 2425000.095 + 0^d_.6278128\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 080.595:	—17393	+$^d_.$048:
L	1921	22 730.544:	— 3615	—.008:
M	1925	24 287.535	— 1135	+.008
G	1926	24 647.875	— 561	—.017
Bp	1938	28 963.492:	+ 6313	+.015:
Ma	1940	29 770.247	+ 7598	+.030
Bp	1940	29 775.251:	+ 7606	+.012:
	1941	30 078.491	+ 8089	+.018
	1950	33 420.346:	+13412	+.026:
	1952	34 118.472	+14524	+.024
RS	1953	34 507.722	+15144	+.030
Bp	1955	35 223.431	+16284	+.032
	1956	35 603.261:	+16889	+.036:
	1957	35 933.500:	+17415	+.045:
	1960	37 058.548:	+19207	+.053:
	1962	37 791.222:	+20374	+.069:

Var 49 The light curve is subjected to strong variations amounting to $0^m.7$ in the maxima. Larink obtained low, while Müller high maxima. The amplitude of the O—C oscillations amounts to $0^h.25$. The residuals were computed with the formula:

$$C = 242\,5000.508 + 0^d.5482196\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1898	J. D. 2414 456.546:	—19233	—^{d}054:
L	1921	22 761.591	— 4084	+.012
M	1925	24 284.533	— 1306	.000
		24 289.454	— 1297	—.013
G	1926	24 684.731	— 576	—.003
Ma	1940	29 770.007	+ 8700	—.012
Bp	1940	29 774.392	+ 8708	—.012
	1952	34 118.457	+16632	—.039
	1953	34 487.404	+17305	—.044
	1957	35 933.586	+19943	—.065
	1960	37 018.507	+21922	—.071
	1962	37 791.482	+23332	—.086

Var 50 The light curve is subjected to strong variations. The differences in the height of maxima amount to $0^m.65$ at least. Variations in the depth of minima amounting to several decimals of the magnitude may be considered as certain as well. The amplitude of the O—C variations during the secondary period amounts to 1^h at least. The O—C diagram of the star is of a very complex structure, the period shows several strong sudden changes. The residuals were calculated with the formula:

$$C = 2425000.357 + 0^d.5130879\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 384.522	—22639	—^{d}038
	1896	13 664.687:	—22093	—.019:
	1897	14 073.619:	—21296	—.018:
H	1915	20 625.789	— 8526	+.019
L	1921	22 733.462	— 4418	—.073
		22 756.584	— 4373	—.040
M	1925	24 298.518:	— 1368	+.065:
G	1926	24 684.807	— 615	—.001
Bp	1938	28 963.480:	+ 7724	+.032:
H	1939	29 400.666:	+ 8576	+.067:
Ma	1940	29 770.040	+ 9296	+.018
Bp	1941	30 078.418	+ 9897	+.030
Be	1946	31 971.737	+13587	+.055
	1948	32 683.833:	+14975	—.015:
Bp	1952	34 121.493	+17777	—.028
RS	1953	34 483.699	+18483	—.062
Bp	1957	35 920.430:	+21283	+.023:
	1960	37 018.444:	+23423	+.029:

Var 51 The rate of the decrease of the period is diminishing. On the rising branch a hump is indicated (mainly by Belserene's and Roherts and Sandage's observations). The (O—C)-s were calculated using the formula:

$$C = 2425000.571 + 0^d_.5839818\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 377.520:	—19903	—$^d_.$061:
	1899	14 841.567:	—17396	—.057:
L	1921	22 760.419	— 3836	+.002
M	1925	24 290.443	— 1216	—.006
G	1926	24 647.848	— 604	+.002
H	1939	29 423.633	+ 7574	—.016
Ma	1940	29 770.517	+ 8168	—.017
Bp	1941	30 078.275:	+ 8695	—.018:
Be	1946	31 993.723	+11976	—.030
	1948	32 682.817	+13155	—.035
Bp	1950	33 421.553:	+14420	—.036:
	1952	34 120.575	+15617	—.040
RS	1953	34 483.799	+16239	—.052
Bp	1953	34 487.310:	+16245	—.045:
	1956	35 600.371	+18151	—.054
	1960	36 991.408:	+20533	—.061:
	1962	37 791.448	+21903	—.076

Var 52 The light curve is variable. In the Budapest material the maxima do not indicate great differences in height (only about$0^m_.3$) but the differences are much greater according to other observers (Müller's maxima are very high). The minima show variations of about $0^m_.1$. The oscillations in O—C produced by the variations of the light curve are insignificant. The O—C diagram is very complicated and its course is quite uncertain before Larink's observations. A shift of 1P is possible between Baker's and Larink's material. Hett, Belserene and Roberts and Sandage's observations and especially the Mt. Wilson material are badly lacking. The O—C diagram was constructed using the formula:

$$C = 2425000.073 + 0^d_.5162250\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 384.528	—22501	+$^d_.$036
	1897	14 071.614	—21170	+.024
	1900	15 160.835	—19060	+.010
L	1921	22 756.625:	— 4346	+.066:
M	1925	24 313.497	— 1330	+.003
S	1926	24 642.853	— 692	+.008
G	1926	24 684.661:	— 611	+.001:
Bp	1938	28 991.453	+ 7732	—.072
Ma	1940	29 770.319:	+ 9241	—.189:
Bp	1941	30 078.502	+ 9838	—.193
	1951	33 763.495	+16976	—.014
	1952	34 126.425:	+17679	+.010:
	1955	35 227.571	+19812	+.048
	1956	35 603.428	+20540	+.093

Var 53 The star is situated rather close to the centre, the magnitudes obtained are systematically high. The positive parabola represents a good approximation for the O—C values. The diagram was constructed using the formula:

$$C = 2425000.118 + 0^d.5048878 \text{ E.}$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 372.514:	—23030	—^{d}.038:
	1896	13 694.642:	—22392	—.028:
	1900	15 161.846	—19486	—.028
L	1921	22 760.431	— 4436	—.005
M	1925	24 309.431	— 1368	.000
G	1926	24 647.705	— 698	—.001
Ma	1940	29 770.294	+ 9448	—.005
Bp	1940	29 775.330:	+ 9458	—.018:
	1941	30 078.273:	+10058	—.007:
	1951	33 763.437	+17357	—.020
	1952	34 118.369	+18060	—.024
	1953	34 487.443	+18791	—.023
	1955	35 224.577	+20251	—.025
	1956	35 603.240:	+21001	—.028:
	1957	35 933.432	+21655	—.032
	1960	37 018.433:	+23804	—.035:
	1962	37 791.412	+25335	—.039

Var 54 The star lies near the centre in a rather dense region. Therefore the scatter is considerably higher than usually. In spite of this fact the variation of the light curve can be established with certainty. The differences in the heights of maxima amount only to about 0^m2,hence normal points were formed along the entire light curve. The differences in the residuals O—C arising from light curve variations have an amplitude of about $0^h.25$, but if Müller's plates taken on J. D. 2424289 are correctly estimated, these differences may amount to $1^h.5$ as well. The period is subjected to rather strong variations, and the period given by the author seems to fit the observations to the best. The O—C diagram, especially before Larink's observations is, rather uncertain. The different groups of points may be shifted upwards or downwards by a multiple of the period. The measurement of Mt. Wilson plates of 1912, 1915, 1946 and 1948 would be of great importance. Using the Budapest material the following limits can be fixed for the O—C values: in 1939 ($-0^d.039$; $+0^d.011$); in 1950 ($-0^d.074$; -0.027), in 1953 ($+0^d.078$; $+0^d.234$) and in 1957 ($+0^d.359$; $+0^d.429$). The residuals were computed with the formula:

$$C = 2425000.125 + 0^d.5063150 \text{ E.}$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 372.498	—22966	+^{d}.403
	1896	13 694.472:	—22330	+.361:
	1897	14 071.635	—21585	+.319
	1898	14 456.367:	—20825	+.252:
	1900	15 161.543:	—19432	+.131:

Observer	Year	t(med)hel.	E	O—C
L	1921	J. D. 2422 761.486	— 4421	—$^{d}_{.}$220
M	1925	24 284.527	— 1413	—.175
S	1926	24 621.855	— 747	—.053
G	1926	24 647.679	— 696	—.051
Bp	1938	28 991.409:	+ 7883	+.003:
	1940	29 775.178:	+ 9431	—.003:
Ma	1940	29 780.245	+ 9441	.000
		29 781.270	+ 9443	+.012
Bp	1941	30 078.478	+10030	+.014
	1951	33 763.360:	+17308	—.065:
	1952	34 121.405	+18015	+.015
	1955	35 223.419	+20191	+.288
	1956	35 603.242	+20941	+.375
	1960	36 991.510:	+23683	+.327:
	1962	37 791.400:	+25263	+.239:

Var 55 The star is a well measurable RRab variable. The O—C diagram can be represented by a positive parabola. The residuals were calculated by the formula:

$$C = 2425000.122 + 0^{d}_{.}5298132 \text{ E.}$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 383.486:	—21926	+$^{d}_{.}$048:
	1897	14 078.593	—20614	+.040
L	1921	22 760.605	— 4227	+.003
M	1925	24 313.484	— 1296	.000
S	1926	24 620.776	— 716	.000
G	1926	24 647.796	— 665	.000
H	1939	29 408.707	+ 8321	+.009
Ma	1940	29 770.040	+ 9003	+.010
Bp	1940	29 775.340:	+ 9013	+.012:
	1941	30 078.396:	+ 9585	+.014:
Be	1946	31 968.778	+13153	+.023
Bp	1950	33 420.470	+15893	+.027
	1951	33 763.267:	+16540	+.035:
	1952	34 121.419	+17216	+.033
RS	1953	34 482.749	+17898	+.030
Bp	1953	34 487.517	+17907	+.030
	1955	35 224.494	+19298	+.037
	1956	35 603.312:	+20013	+.038:
	1957	35 933.387:	+20636	+.040:
	1960	37 018.453:	+22684	+.048:
	1962	37 791.458	+24143	+.056

Var 56 The star is an RRc variable. In the O—C diagram several oscillations can be established with certainty although the period seems to be rather stable. The normal points do not give a smooth light curve at the maximum. This can arise from the inaccuracy of the measurements, but a double maximum is also possible. The O—C values were calculated with the formula:

$$C = 2425000.211 + 0^{d}.3295986\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 383.497:	—35245	—^{d}.011:
	1897	14 077.633:	—33139	—.010:
H	1915	20 625.769	—13272	—.009
L	1921	22 761.582	— 6792	+.005
M	1925	24 309.385:	— 2096	+.013:
S	1926	24 620.843	— 1151	.000
G	1926	24 683.800	— 960	+.004
Sch	1938	28 983.745:	+12086	+.005:
H	1939	29 431.671	+13445	+.007
Ma	1940	29 770.153	+14472	—.009
Bp	1940	29 775.429:	+14488	—.007:
Be	1946	31 974.842	+21161	—.005
	1948	32 682.820:	+23309	—.005:
Bp	1950	33 422.444	+25553	.000
	1952	34 120.523	+27671	—.011
RS	1953	34 447.812	+28664	—.013
Bp	1953	34 487.360:	+28784	—.017:
	1955	35 223.360:	+31017	—.011:
	1956	35 600.422	+32161	—.010
	1957	35 920.458	+33132	—.014
	1960	37 057.572:	+36582	—.015:
	1962	37 791.588:	+38809	—.015:

Var 57 Unfortunately the Budapest material contains only a few ascending branches, therefore difficulties arise in constructing a reliable mean curve. The poor material does not enable us to reveal variations of the light curve, but Greenstein's ascending branches show obviously different slopes. The decrease of the period is very pronounced. The O—C diagram was constructed with the formula:

$$C = 2425000.328 + 0^{d}.5122223\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 664.669:	—22130	—^{d}.180:
	1897	14 077.532	—21324	—.168
L	1921	22 729.641	— 4433	—.006
M	1925	24 292.433	— 1382	—.003
G	1926	24 683.774	— 618	—.001
Bp	1938	28 991.534	+ 7792	—.030
Ma	1940	29 770.117	+ 9312	—.025
Bp	1940	29 775.237:	+ 9322	—.027:
	1941	30 078.460	+ 9914	—.040
	1950	33 390.432:	+16380	—.097:
	1951	33 763.323:	+17108	—.104:
	1952	34 122.380:	+17809	—.115:
RS	1953	34 482.975	+18513	—.124
Bp	1956	35 603.184:	+20700	—.146:
	1957	35 933.542:	+21345	—.171:
	1960	37 018.380:	+23463	—.220:
	1962	37 791.309:	+24972	—.234:

Var 58 Although Baker's observations are rather poor, they suggest definitely a period of about $0^d.5167$. The O—C diagram is discontinuous between Baker's and Larink's material. The Mt. Wilson plates of 1912 and 1915 would be of great importance. After J. D. 2422700 the decrease of the period is slowing down. It is not possible to approximate the O—C diagram with a parabola for the 40 year interval from J. D. 2422700 to J. D. 2437800. The star is situated in a dense region with close neighbours, in the inner part of the cluster. Variations of the light curve, indicated by the complexity of the O—C diagram, could not be observed. The O—C diagram was constructed with the formula:

$$C = 2425000.179 + 0^d.5170617\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 399.511:	—22437	$+^d.645$:
	1896	13 694.524:	—21866	+.416:
	1897	14 036.592:	—21204	+.189:
	1898	14 437.537:	—20428	—.106:
	1899	14 840.543:	—19648	—.408:
L	1921	22 761.644	— 4329	—.175
M	1925	24 313.472	— 1328	—.049
S	1926	24 642.862	— 691	—.027
G	1926	24 683.709	— 612	—.028
Ma	1940	29 770.333	+ 9225	+.260
Bp	1941	30 078.510	+ 9821	+.268
	1950	33 422.460	+16288	+.380
	1951	33 763.734:	+16948	+.393:
	1952	34 121.542	+17640	+.395
	1953	34 488.667	+18350	+.406
	1955	35 227.562	+19779	+.420
	1956	35 603.470	+20506	+.424
	1960	37 058.503:	+23320	+.445:
	1962	37 757.571:	+24672	+.446:

Var 59 Larink's observations suggest variations in the light curve. There are conspicuous differences in the height of maxima and in the O—C residuals of the median point on the rising branch. The other observations contain only few rising branches and maxima. The rate of period increase gets higher. The residuals were computed with the formula:

$$C = 2425000.325 + 0^d.5888053\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 693.545:	—19203	$+^d.048$:
	1899	14 840.532:	—17255	+.042:
	1900	15 160.855	—16711	+.055
H	1915	20 656.726:	— 7377	+.018:
L	1921	22 730.502	— 3855	+.021
		22 760.518	— 3804	+.008
M	1925	24 298.471	— 1192	+.002
S	1926	24 621.724	— 643	+.001
G	1926	24 684.725	— 536	.000

Observer	Year	t(med)hel.	E	O−C
H	1939	J. D. 2429 431.678	+ 7526	+^{d}004
Ma	1940	29 770.242	+ 8101	+.005
Bp	1941	30 052.293:	+ 8580	+.019:
Be	1946	31 994.764	+11879	+.021
	1948	32 684.847	+13051	+.024
Bp	1950	33 421.457	+14302	+.039
	1952	34 121.546	+15491	+.038
RS	1953	34 507.803	+16147	+.039
Bp	1955	35 224.406:	+17364	+.066:
	1957	35 920.374:	+18546	+.066:
	1960	37 018.509	+20411	+.079
	1962	37 757.459:	+21666	+.078:

Var 60 This variable has flat, badly defined ascending branches and this gives rise to scatter in the O—C diagram. The characteristics of the light curve are like those of RRab stars with a period shorter by about $0^d\!.1$. (The star belongs to the long period sequence.) The O—C values were computed using the formula:

$$C = 2425000.211 + 0^d\!.7077228\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1896	J. D. 2413 691.544:	—15979	+^{d}036:
	1899	14 841.570:	—14354	+.012:
	1900	15 160.759:	—13903	+.018:
L	1921	22 730.546	— 3207	+.002
M	1925	24 309.478	— 976	+.004
S	1926	24 620.872	— 536	.000
G	1926	24 647.754	— 498	—.011
Bp	1938	28 963.454:	+ 5600	—.005:
Ma	1940	29 770.276	+ 6740	+.013
Bp	1950	33 421.418	+11899	+.013
	1952	34 118.522	+12884	+.010
RS	1953	34 482.982	+13399	—.007
Bp	1953	34 487.251:	+13405	+.016:
	1955	35 227.540:	+14451	+.027:
	1956	35 600.503:	+14978	+.020:

Var 61 The light curve varies with certainty, the height of maximum indicates differences amounting to $0^m\!.5$ at least. Larink's material shows phase shifts amounting to $0^h\!.5$ for the middle of the ascending branch, while the minimum remains fixed. Müller's material shows even stronger phase shifts. The O—C diagram is rather complicated, being a superposition of waves of different size. The diagram was constructed with the formula:

$$C = 2425000.025 + 0^d\!.5209312\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 378.507:	—22309	—^{d}064:
	1896	13 692.640:	—21706	—.052:
	1897	14 077.606:	—20967	—.055:

Observer	Year	t(med)hel	E	O—C
B	1898	J. D. 2414 437.566:	—20276	—^{d}058:
	1900	15 161.631:	—18886	—.087:
H	1912	19 534.928	—10491	—.008
	1915	20 625.755	— 8397	—.011
L	1921	22 760.575	— 4299	+.033
M	1925	24 289.529	— 1364	+.054
G	1926	24 647.943	— 676	+.067
Sch	1938	28 964.827:	+ 7611	—.005:
H	1939	29 408.653	+ 8463	—.013
Ma	1940	29 770.194	+ 9157	+.002
Bp	1940	29 775.397	+ 9167	—.004
Be	1946	31 973.682:	+13387	—.049:
	1948	32 683.705	+14750	—.055
Bp	1950	33 422.410	+16168	—.031
	1952	34 121.490	+17510	—.040
	1953	34 567.383:	+18366	—.064:
	1956	35 600.425	+20349	—.029
	1962	37 791.424	+24555	—.067

Var 62 Variations may occur in the light curve. A long constant phase seems to be present on the ascending branch (e.g. an interval of about 1^h observed in Budapest on J. D. 2435603). The residuals were calculated by the formula:

$$C = 2425000.440 + 0\overset{d}{.}6524077\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1900	J. D. 2415 160.855:	—15082	+^{d}028:
H	1915	20 654.751	— 6661	—.001
L	1921	22 761.386:	— 3432	+.009:
M	1925	24 311.495	— 1056	—.002
G	1926	24 684.691	— 484	+.016
Bp	1938	28 991.213:	+ 6117	—.005:
H	1939	29 408.759	+ 6757	.000
Ma	1940	29 770.196	+ 7311	+.003
Bp	1940	29 775.416	+ 7319	+.004
Be	1946	31 970.771	+10684	+.007
	1948	32 683.856	+11777	+.011
Bp	1950	33 420.445:	+12906	+.031:
	1952	34 120.469	+13979	+.022
RS	1953	34 508.647:	+14574	+.017:
Bp	1956	35 603.393	+16252	+.023
	1957	35 933.510:	+16758	+.022:
	1960	37 018.475	+18421	+.033

Var 63 The variable has a varying light curve with differences of about $0\overset{m}{.}4$ at maximum. The (O—C)-s do not exhibit large differences from epoch to epoch and therefore the scatter in the O—C diagram is not considerable. Müller's material shows phase-shifts of $0\overset{h}{.}5$ at most in the course of the secondary period. The negative parabola is a relatively suitable fitting for the O—C diagram, which was constructed using the formula:

$$C = 2425000.547 + 0\overset{d}{.}5704164\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 384.515	−20364	−^{d}072
	1900	15 160.806	−17250	−.058
H	1912	19 534.801:	− 9582	−.016:
	1915	20 656.816:	− 7615	−.010:
L	1921	22 760.519	− 3927	−.003
M	1925	24 287.519	− 1250	−.008
		24 311.492	− 1208	+.008
Sch	1938	28 983.766:	+ 6983	+.001:
H	1939	29 408.712	+ 7728	−.013
Ma	1940	29 770.356	+ 8362	−.013
Be	1946	31 968.719	+12216	−.035
	1948	32 682.872:	+13468	−.043:
Bp	1950	33 420.429	+14761	−.034
	1952	34 121.462	+15990	−.043
RS	1953	34 507.608	+16667	−.069
Bp	1955	35 223.495	+17922	−.055
	1956	35 603.386	+18588	−.061
	1957	35 920.525	+19144	−.074
	1960	37 018.571	+21069	−.079
	1962	37 791.472	+22424	−.092

Var 64 From the Budapest material and Belserene's and Roberts and Sandage's observations the existence of a constant phase on the ascending branch is clearly established. The period is rather stable, the O−C diagram is a straight line. The O−C values have been obtained with the formula:

$$C = 2425000.447 + 0\overset{d}{.}6054588\ E.$$

Observer	Year	t(med)hel	E	O−C
B	1895	J. D. 2413 383.502:	−19187	−$\overset{d}{.}$007:
	1900	15 161.748	−16250	+.006
H	1912	19 479.868	− 9118	−.006
L	1921	22 761.466	− 3698	+.006
M	1925	24 311.436	− 1138	+.001
G	1926	24 683.788	− 523	−.004
Sch	1938	28 983.761:	+ 6579	+.001:
H	1939	29 367.628:	+ 7213	+.007:
Ma	1940	29 770.269	+ 7878	+.018
Bp	1941	30 078.424	+ 8387	−.006
Be	1946	31 968.673	+11509	+.001
	1948	32 700.677	+12718	+.005
Bp	1950	33 422.378	+13910	−.001
	1952	34 120.478	+15063	+.005
RS	1953	34 483.742	+15663	−.006
Bp	1953	34 487.378	+15669	−.003
	1957	35 920.497	+18036	−.005
	1960	37 057.562	+19914	+.008
	1962	37 791.368	+21126	−.002

Var 65 Apparently there are differences in the slopes of the ascending branches. The characteristics of the light curve are similar to those of RRab stars with periods shorter by about $0^d.1$. (The star belongs to the long period sequence.) The residuals O—C were computed with the formula:

$$C = 2425000.438 + 0^d.6683397\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1900	J. D. 2415 161.815	—14721	$+^d.006$
H	1912	19 479.977	— 8260	+.025
	1915	20 626.830:	— 6544	+.007:
L	1921	22 761.507	— 3350	+.007
M	1925	24 309.381:	— 1034	+.006:
G	1926	24 683.642:	— 474	—.003:
Sch	1938	28 983.737:	+ 5960	—.006:
H	1939	29 400.777	+ 6584	—.010
Ma	1940	29 770.378	+ 7137	.000
Bp	1940	29 774.390	+ 7143	+.002
	1941	30 078.476	+ 7598	—.007
Be	1946	31 994.605:	+10465	—.008:
	1948	32 683.669:	+11496	—.002:
Bp	1950	33 421.514	+12600	—.004
	1952	34 121.266:	+13647	—.004:
	1953	34 487.516	+14195	—.004:
RS	1953	34 508.902:	+14227	—.005:
Bp	1955	35 223.361:	+15296	—.001:
	1956	35 600.309:	+15860	+.003:
	1957	35 920.442	+16339	+.002
	1960	37 018.531	+17982	+.009
	1962	37 791.136:	+19138	+.013:

Var 66 The star has a varying light curve with differences of $0^m.3$ in the height of the maximum. The O—C diagram exhibits abrupt variations and great cycles. Prior to Larink's observations it is quite uncertain. Baker's values may be shifted by 1P or 2P downwards. The unmeasured Mt. Wilson plates of 1912 and 1915 represent a considerable want. The (O—C)-s were constructed by the formula:

$$C = 2425000.050 + 0^d.6201827\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 384.481:	—18729	$-^d.167$:
	1897	14 078.500:	—17610	—.133:
	1899	14 839.531:	—16383	—.066:
	1900	15 160.843	—15865	—.008
L	1921	22 760.548	— 3611	—.022
M	1925	24 287.483	— 1149	+.023
S	1926	24 621.761	— 610	+.022
G	1926	24 683.784	— 510	+.027
Ma	1940	29 770.514	+ 7692	+.019
Bp	1940	29 775.465:	+ 7700	+.008:
	1950	33 421.468	+13579	—.043
	1951	33 763.178:	+14130	—.054:

Observer	Year	t(med)hel.	E	O−C
Bp	1952	J. D. 2434 118.535	+14703	$-^{d}.061$
RS	1953	34 483.878	+15292	−.006
Bp	1955	35 224.441	+16486	+.059
	1956	35 603.368	+17097	+.054
	1960	37 018.674:	+19379	+.103:
	1962	37 791.401	+20625	+.083

Var 67 The star has a strongly variable light curve. The differences in the height of maximum amount to $0^{m}.5$ at least, those of the minimum to about $0^{m}.1-0^{m}.2$. The medium point of the ascending branch shows little phase-shifts in the course of the light curve variations. Therefore, in spite of the considerable variations of the light curve, the scatter in the O−C diagram is very small. The diagram was constructed with the formula:

$$C = 2425000.199 + 0^{d}.5683609\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1896	J. D. 2413 664.642:	−19944	$-^{d}.167$:
	1897	14 079.559:	−19214	−.154:
	1900	15 161.750	−17310	−.122
L	1921	22 761.417	− 3939	−.008
M	1925	24 312.483	− 1210	+.001
S	1926	24 642.698	− 629	−.002
G	1926	24 647.814	− 620	−.001
Ma	1940	29 770.433	+ 8393	−.019
Bp	1940	29 744.399	+ 8400	−.032
	1941	30 078.469	+ 8935	−.035
Be	1946	31 968.813	+12261	−.059
	1948	32 683.804	+13519	−.066
Bp	1950	33 421.515	+14817	−.087
	1952	34 120.581	+16047	−.105
RS	1953	34 483.756	+16686	−.113
Bp	1956	35 603.398	+18656	−.142
	1957	35 920.522	+19214	−.163
	1960	37 018.575	+21146	−.184
	1962	37 791.522	+22506	−.207

Var 68 The star is one of the most interesting variables in M3. It is probably of RRc type with such extremely strong light curve variations, that it has no sense to construct normal points even for a limited part of the light curve. The height of maximum varies with an amplitude of $0^{m}.7$ at least, while differences of the brightness of minimum amount to several decimals of a magnitude. Martin's period seems to be correct, however, it provides large residuals amounting to $0^{d}.12 = 3^{h}$, i.e. the 1/3 of the period for the median point of the ascending branch. Using Martin's period, a secondary period of $10^{d}.9$ can be deduced from Müller's well observed ascending branches (Figure 14). In this way the shortest beat period of RR Lyrae variables has been assigned to this star. The shortness of this secondary period gives account of the rapid changes in the light curve. No connection between the observations obtained in different years is possible for improving the secondary period. In the O−C

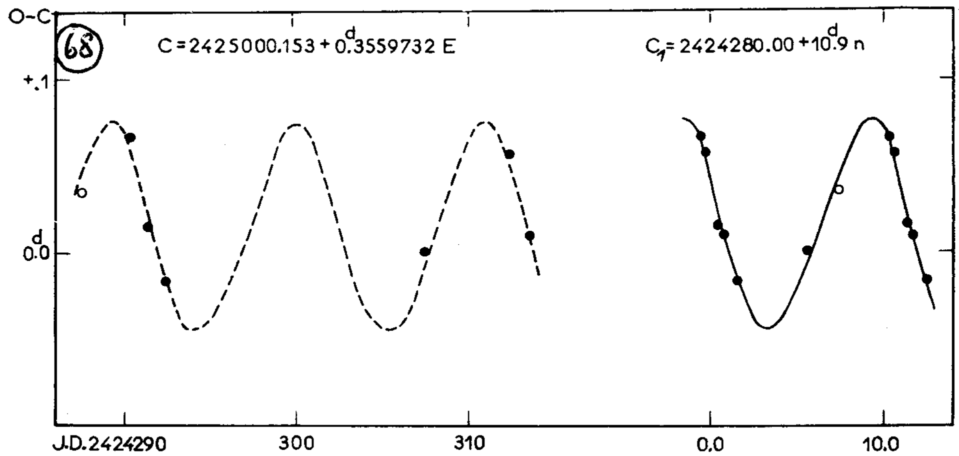


Fig. 14.

diagram the weighted means of the residuals obtained from our observations are shown. Of course both the fundamental and the secondary period are yet questionable, the observational material being too poor for a final decision. The O—C diagram was computed with the formula:

$$C = 2425000.153 + 0^d\!.3559732\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 386.507:	—32625	—.ᵈ020:
	1900	15 161.714:	—27638	—.052:
L	1921	22 730.510	— 6376	+.042
		22 756.448	— 6303	—.006
		22 761.408:	— 6289	—.030:
M	1925	24 287.531:	— 2002	+.036:
		24 290.409	— 1994	+.067
		24 291.426	— 1991	+.016
		24 292.462	— 1988	—.016
		24 307.430	— 1946	+.001
		24 312.470	— 1932	+.057
		24 313.491	— 1929	+.010
G	1926	24 647.765:	— 990	+.025:
		24 684.772	— 886	+.011
Bp	1941	30 078.483	+14266	+.016
	1950	33 421.382	+23657	—.029
		33 422.419	+23660	—.060
	1951	33 763.490	+24618	—.011
	1952	34 118.440	+25615	+.033
		34 120.503	+25621	—.039
RS	1953	34 447.695:	+26540	+.013:
		34 507.840	+26709	—.001
Bp	1955	35 227.596	+28731	—.023
	1956	35 598.545:	+29773	+.002:
		35 600.367	+29778	+.044
	1957	35 933.505	+30714	—.009
	1960	36 991.480	+33686	+.014
		37 018.500	+33762	—.020
	1962	37 791.300:	+35933	—.038:

Var 69 The star has a close companion, therefore the measures are uncertain and the scatter is considerable. The light curve outlined by the normal points is probably heavily distorted and the brightness data are not real. The residuals were computed with the formula:

$$C = 2425000.106 + 0\overset{d}{.}5665878\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1900	J. D. 2415 160.847	−17366	$+\overset{d}{.}105$
L	1921	22 756.431	− 3960	+.013
M	1925	24 309.435	− 1219	.000
G	1926	24 647.688	− 622	.000
Ma	1940	29 770.229	+ 8419	+.020
Bp	1941	30 078.457	+ 8963	+.025
	1950	33 422.511	+14865	+.077
	1952	34 120.565:	+16097	+.095:
	1956	35 600.520	+18709	+.123
	1962	37 791.575:	+22576	+.183:

Var 70 The period is very probably about $0\overset{d}{.}486$, however its strong variations in both directions make the construction of the O−C diagram and of the mean light curve impossible. The star is probably of RRc type.

Var 71 The star lies near var 54. On plates of poor quality they are blurred together providing a considerable scatter. Larink's observations on J.D. 2422760 show peculiar scatter. The O−C diagram consists of several small cycles. It was calculated with the formula:

$$C = 2425000.139 + 0\overset{d}{.}5490517\ E$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 079.540:	−19890	$+\overset{d}{.}039$:
	1900	15 161.698:	−17919	+.016:
L	1921	22 760.565	− 4079	+.008
M	1925	24 309.437	− 1258	+.005
G	1926	24 647.647:	− 642	−.001:
Ma	1940	29 770.335	+ 8688	+.035
Bp	1941	30 078.358:	+ 9249	+.040:
	1950	33 421.523	+15338	+.029
	1952	34 121.564	+16613	+.029
RS	1953	34 447.702	+17207	+.030
Bp	1953	34 567.393:	+17425	+.028:
	1955	35 223.511	+18620	+.029
	1956	35 603.455	+19312	+.030
	1960	36 991.461	+21840	+.033
	1962	37 791.430	+23297	+.034

Var 72 The star is of RRab type having a large amplitude and a steep ascending branch. The residuals were computed with the formula:

$$C = 2425000.166 + 0\overset{d}{.}4560739\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 378.519:	—25482	+.ᵈ028:
	1899	14 841.593:	—22274	+.017:
	1900	15 161.763	—21572	+.023
H	1915	20 654.695:	— 9528	+.001:
L	1921	22 733.483	— 4970	+.004
M	1925	24 311.491	— 1510	—.003
Sch	1938	28 964.824:	+ 8693	+.008:
H	1939	29 423.633	+ 9699	+.006
Bp	1940	29 720.543	+10350	+.012
Ma	1940	29 770.250	+10459	+.007
Bp	1941	30 078.561:	+11135	+.012:
Be	1946	31 971.726	+15286	+.014
	1948	32 682.746	+16845	+.015
Bp	1950	33 422.499	+18467	+.016
	1952	34 118.468	+19993	+.017
RS	1953	34 483.780	+20794	+.013
Bp	1953	34 487.434	+20802	+.019
	1955	35 223.542	+22416	+.023
	1956	35 603.453	+23249	+.025
	1960	37 057.424:	+26437	+.032:
	1962	37 791.248:	+28046	+.033:

Var 73 The star is a variable of small range, the period is longer than half a day.

Var 74 The section of the O—C diagram preceding Müller's observations is uncertain, the Mt. Wilson material of 1912 and 1915 would be of great importance. The O—C diagram was calculated using the formula:

$$C = 2425000.082 + 0\overset{d}{.}4921441\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 386.514:	—23598	+.ᵈ048:
	1896	13 691.629:	—22978	+.034:
M	1925	24 290.412	— 1442	+.002
G	1926	24 647.708	— 716	+.001
Ma	1940	29 770.448	+ 9693	+.013
Bp	1941	30 078.532	+ 10319	+.015
	1950	33 421.191:	+17111	+.031:
	1952	34 120.527	+18532	+.031
RS	1953	34 483.728	+19270	+.029
Bp	1953	34 567.397:	+19440	+.034:
	1955	35 223.426	+20773	+.035
	1956	35 600.410	+21539	+.036
	1960	37 018.282:	+24420	+.041:
	1962	37 791.447	+25991	+.048

Var 75 According to Larink's observations the star is of RRc type with varying light curve. There is a difference of $0\overset{m}{.}37$ between the maxima of J. D. 2422729.60 and J. D. 2422761.63 although the scatter is considerable. The faint-

ness of the last maximum is very strange, as the maximum on the preceding day, J. D. 2422760.7 seems to be high. The O—C diagram was constructed with the ephemeris:

$$C = 2425000.032 + 0\overset{d}{.}3140790\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 077.600:	—34776	—.ᵈ021:
	1900	15 161.807:	—31324	—.014:
L	1921	22 760.647	— 7130	—.002
M	1925	24 290.535	— 2259	+.007
G	1926	24 684.695	— 1004	—.002
Ma	1940	29 770.268	+15188	+.004
Bp	1940	29 775.296:	+15204	+.007:
	1941	30 078.380:	+16169	+.005:
	1950	33 420.500	+26810	+.010
	1951	33 763.471	+27902	+.007
	1952	34 121.520	+29042	+.006
	1953	34 487.419	+30207	+.003
RS	1953	34 508.776	+30275	+.002
Bp	1955	35 224.554	+32554	—.006
	1956	35 600.497	+33751	—.015
	1957	35 920.540	+34770	—.019
	1960	37 018.551:	+38266	—.028:
	1962	37 791.491	+40727	—.036

Var 76 The star is close to the centre, the observations are very uncertain. In spite of that, the errors of the O—C values do not exceed the average, due to the large amplitude and steep rising branch of the light curve. The descending branch is unusually steep. The residuals O—C were computed using the formula:

$$C = 2425000.148 + 0\overset{d}{.}5017544\ E.$$

Observer	Year	t(med)hel	E	O—C
B	1895	J. D. 2413 372.519:	—23174	+.027:
	1896	13 691.637:	—22538	+.030:
	1900	15 161.768	—19608	+.020
G	1926	24 647.916	— 702	.000
Ma	1940	29 770.340	+ 9507	+.013
Bp	1941	30 078.414	+10121	+.010
	1950	33 390.502	+16722	+.017
	1952	34 120.554	+18177	+.016
	1953	34 487.338:	+18908	+.018:
	1955	35 223.409	+20375	+.015
	1957	35 933.397:	+21790	+.021:
	1962	37 791.420	+25493	+.047

Var 77 The star lies near the centre, the scatter is considerable and the observations are systematically too bright. The O—C diagram was constructed with the formula:

$$C = 2425000.162 + 0^d\!.4593425\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 692.543:	—24617	+^{d}.015:
	1898	14 438.521:	—22993	+.021:
L	1921	22 730.561	— 4941	+.010
M	1925	24 291.399	— 1543	+.002
S	1926	24 642.796	— 778	+.002
G	1926	24 683.675	— 689	.000
Bp	1938	28 991.391:	+ 8689	+.002:
Ma	1940	29 770.441	+10385	+.007
Bp	1941	30 052.480	+10999	+.010
	1950	33 390.529	+18266	+.017
	1951	33 763.517	+19078	+.019
	1952	34 120.436:	+19855	+.029:
	1953	34 487.443	+20654	+.021
	1956	35 600.428	+23077	+.019
	1957	35 933.455:	+23802	+.023:
	1960	37 018.429:	+26164	+.030:
	1962	37 791.507	+27847	+.034

Var 78 The star is close to the centre, the scatter is significant, and the observations are systematycally higher. The flat slope of the ascending branches and the small range increase the uncertainty in determining the epochs. Martin's epoch deviates conspicuously from our O—C diagram. The rate of the period-increase shows a growing tendency during the last 60 years. The O—C diagram was constructed with the formula:

$$C = 2425000.440 + 0^d\!.6119254\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1900	J. D. 2415 160.701:	—16080	+^{d}.021:
L	1921	22 756.508	— 3667	—.002
M	1925	24 292.454	— 1157	+.012
G	1926	24 684.686	— 516	.000
Bp	1938	28 991.412	+ 6522	—.005
Ma	1940	29 770.460:	+ 7795	+.062:
Bp	1950	33 390.560	+13711	+.011
	1953	34 567.304:	+15634	+.022:
	1955	35 227.574	+16713	+.025
	1962	37 791.573	+20903	+.056

Var 79 The light curve varies with an amplitude of $0^m\!.5$ in the maximum light and of about $0^h\!.5$ in the O—C residuals. No period was found which would have satisfied Baker's observations. The O—C diagram has a discontinuity between J. D. 2424700 and 2429000. The intermediate observations are lacking very much. The O—C diagram computed with the formula:

$$C = 2425000.077 + 0^{d}\!.4833275\ E$$

is rather complicated.

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 372.554:	−24057	$-^{d}\!.113$:
	1896	13 724.645:	−23329	+.115:
	1897	14 078.541:	−22597	+.216:
	1898	14 437.530:	−21854	+.092:
	1899	14 841.592:	−21018	+.092:
H	1912	19 534.801	−11308	+.191
	1915	20 625.642:	− 9051	+.162:
L	1921	22 730.528	− 4696	+.157
		22 760.478	− 4634	+.141
M	1925	24 309.473	− 1429	+.071
G	1926	24 647.731	− 729	.000
Bp	1938	28 991.520	+ 8258	+.125
H	1939	29 408.663	+ 9121	+.156
Ma	1940	29 770.202	+ 9869	+.166
Bp	1941	30 052.476	+10453	+.177
Be	1946	31 974.682	+14430	+.189
	1948	32 682.749	+15895	+.181
Bp	1951	33 763.442	+18131	+.154
	1952	34 121.586	+18872	+.152
	1953	34 487.470	+19629	+.158
RS	1953	34 508.733	+19673	+.154
Bp	1955	35 224.534	+21154	+.147
	1956	35 603.468	+21938	+.152
	1957	35 933.573	+22621	+.145
	1960	37 018.644	+24866	+.145
	1962	37 791.450	+26465	+.111

Var 80 The star has a considerably varying light curve, differences of at least $0^{m}\!.7$ can be taken certain in the height of maximum, while the phase-shifts are unsignificant. There is an abrupt change in the course of the O−C diagram at about J. D. 2429500. Before this abrupt change in the period some variations of the light curve can be detected (Larink, Müller, Greenstein), the phenomenon is however not very significant. The residuals were computed with the formula:

$$C = 2425000.073 + 0^{d}\!.5384827\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 380.522:	−21577	$-^{d}\!.710$:
	1897	14 079.525	−20279	−.657
	1898	14 456.494:	−19579	−.626:
	1899	14 841.565:	−18864	−.570:
H	1912	19 479.791:	−10251	−.296:
	1915	20 625.775	− 8123	−.203
L	1921	22 760.441	− 4159	−.082
M	1925	24 313.488	− 1275	−.020
G	1926	24 647.887	− 654	−.018
Bp	1938	28 991.468	+ 7412	+.161
H	1939	29 400.744	+ 8172	+.190
Bp	1940	29 774.410	+ 8866	+.149

Observer	Year	t(med)hel.	E	O−C
Ma	1940	J. D. 2429 780.325	+ 8877	+^{d}.141
		29 781.400	+ 8879	+.139
Bp	1941	30 078.564:	+ 9431	+.061:
Be	1946	31 994.748	+12990	—.215
	1948	32 700.716:	+14301	—.198:
Bp	1950	33 390.470:	+15582	—.240:
	1952	34 118.483	+16934	—.256
	1955	35 224.514	+18988	—.269
	1956	35 600.326:	+19686	—.317:
	1957	35 920.531	+20281	—.510
	1960	36 991.404:	+22270	—.679:
	1962	37 791.559	+23756	—.709

Var 81 The period seems to be rather constant, the O—C diagram contains only little waves. The diagram was constructed with the formula:

$$C = 2425000.316 + 0^{d}.5291105\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 380.543:	—21961	+^{d}.023:
	1896	13 691.660:	—21373	+.023:
H	1915	20 654.730	— 8213	—.001
L	1921	22 760.592	— 4223	+.001
M	1925	24 284.428	— 1353	—.001
G	1926	24 647.929	— 666	+.001
Bp	1938	28 991.407	+ 7543	+.010
H	1939	29 431.629	+ 8375	+.013
Bp	1940	29 720.527:	+ 8921	+.016:
Ma	1940	29 770.261	+ 9015	+.014
Be	1946	31 995.700	+13221	+.014
Bp	1951	33 763.460	+16562	+.016
	1952	34 126.431	+17248	+.017
RS	1953	34 507.918:	+17969	+.015:
Bp	1955	35 227.514:	+19329	+.021:
	1956	35 603.182:	+20039	+.021:
	1960	37 018.562	+22714	+.030

Var 82 The star is a typical RRab variable with steep ascending branch and large amplitude. The residuals O—C calculated by the formula:

$$C = 2425000.171 + 0^{d}.5245061\ E$$

outline a positive parabola.

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 372.512:	—22169	+^{d}.117:
	1897	14 079.527:	—20821	+.098:
L	1921	22 761.589	— 4268	+.010
M	1925	24 289.466	— 1355	+.001
G	1926	24 647.703	— 672	.000

Observer	Year	t(med)hel.	E	O−C
Bp	1938	J. D. 2428 963.344:	+ 7556	+^{d}005:
Ma	1940	29 770.045	+ 9094	+.016
Bp	1941	30 078.453	+ 9682	+.014
	1952	34 121.391	+17390	+.059
	1953	34 487.510	+18088	+.073
	1955	35 224.451	+19493	+.083
	1956	35 600.526	+20210	+.087
	1957	35 920.486	+20820	+.098
	1960	37 018.303:	+22913	+.124:
	1962	37 791.437	+24387	+.136

Var 83 The star has a large amplitude and a steep rising branch. A positive parabola fits the residuals well which are calculated using the formula:

$$C = 2425000.113 + 0^{d}.5012408\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 383.500:	−23176	+^{d}144:
	1900	15 161.850	−19628	+.091
H	1912	19 479.975:	−11013	+.027:
	1915	20 625.801	− 8727	+.016
L	1921	22 761.579	− 4466	+.007
M	1925	24 309.406:	− 1378	+.003:
S	1926	24 642.728	− 713	.000
G	1926	24 684.833	− 629	.000
Bp	1938	28 991.510:	+ 7963	+.017:
	1939	29 346.386:	+ 8671	+.014:
Ma	1940	29 770.441	+ 9517	+.019
Bp	1940	29 775.452:	+ 9527	+.018:
Be	1948	32 683.690	+15329	+.057
Bp	1950	33 421.529	+16801	+.069
	1951	33 763.378	+17483	+.072
RS	1953	34 508.734	+18970	+.083
Bp	1953	34 567.386:	+19087	+.090:
	1955	35 223.520	+20396	+.100
	1956	35 600.460	+21148	+.107
	1960	37 018.500	+23977	+.136
	1962	37 791.432	+25519	+.155

Var 84 A hump can be suspected in the ascending branch. The O−C diagram is probably a negative parabola but a sinusoidal wave represents it equally well. The residuals were calculated by the formula:

$$C = 2425000.256 + 0^{d}.5957289\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 383.536:	−19500	−^{d}006:
	1897	14 071.596:	−18345	−.013:
	1900	15 161.783	−16515	−.010
L	1921	22 730.528	− 3810	−.001

Observer	Year	t(med)hel.	E	O—C
M	1925	J. D. 2424 298.486	— 1178	—^{d}001
Ma	1940	29 770.260	+ 8007	+.003
Bp	1940	29 774.430:	+ 8014	+.003:
	1941	30 078.254:	+ 8524	+.005:
	1950	33 421.470	+14136	—.010
	1951	33 763.422	+14710	—.006
	1952	34 118.474	+15306	—.009
RS	1953	34 447.903	+15859	—.018
Bp	1953	34 487.234:	+15925	—.005:
	1955	35 223.550	+17161	—.010
	1957	35 920.551	+18331	—.011
	1960	37 018.484:	+20174	—.007:

Var 85 The star is of RRc type. Baker's observations are of poor quality. Small differences are probable from epoch to epoch. The O—C diagram consists of small and large cycles separated by abrupt changes. On basis of this evidence variations of the light curve can be expected. Most of the maxima seem to be double. The O—C diagram was constructed with the formula:

$$C = 2425000.158 + 0^{d}_{.}3558189 \text{ E}.$$

Observer	Year	t(med)hel.	E	O—C
B	1900	J. D. 2415 161.735	—27650	—^{d}030
H	1912	19 479.931	—15514	—.053
	1915	20 654.832	—12212	—.066
L	1921	22 760.582:	— 6294	—.052:
M	1925	24 292.417	— 1989	—.017
G	1926	24 647.892	— 990	—.005
H	1939	29 408.737	+12390	—.017
Ma	1940	29 770.247	+13406	—.019
Bp	1941	30 078.390:	+14272	—.015:
Be	1946	31 971.746	+19593	+.028
	1948	32 683.749:	+21594	+.038:
Bp	1950	33 422.419	+23670	+.028
	1951	33 763.274:	+24628	—.008:
	1952	34 120.486	+25632	—.022
RS	1953	34 482.714	+26650	—.018
Bp	1953	34 487.349	+26663	—.008
	1955	35 223.516	+28732	—.031
	1956	35 600.330	+29791	—.029
	1960	37 018.625	+33777	—.028
	1962	37 791.443	+35949	—.049

Var 86 The star is of RRc type. Belserene's and Roberts and Sandage's observations suggest irregularities, but the Budapest material does not prove this conclusion. The normal points do not outline the exact shape of the light curve. The residuals were calculated using the formula:

$$C = 242\,5000.233 + 0^d.2926601 \;\; E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 386.523:	−39683	−^{d}.079:
	1897	14 079.545:	−37315	−.076:
	1899	14 841.636:	−34711	−.072:
	1900	15 161.817	−33617	−.061
H	1912	19 534.756	−18675	−.050
	1915	20 625.798	−14947	−.044
L	1921	22 760.487	− 7653	−.018
M	1925	24 310.429	− 2357	−.004
G	1926	24 684.744	− 1078	−.001
Sch	1938	28 965.750:	+13550	−.027:
Bp	1938	28 991.508:	+13638	−.023:
H	1939	29 431.672	+15142	−.020
Bp	1940	29 720.523:	+16129	−.025:
Ma	1940	29 770.272	+16299	−.028
Bp	1941	30 078.431	+17352	−.040
Be	1946	31 970.763	+23818	−.048
	1948	32 683.677	+26254	−.054
Bp	1950	33 421.460	+28775	−.067
	1951	33 763.594	+29944	−.053
	1952	34 121.515	+31167	−.055
	1953	34 487.325:	+32417	−.070:
RS	1953	34 508.696	+32490	−.064
Bp	1955	35 224.535	+34936	−.071
	1956	35 600.315	+36220	−.067
	1957	35 920.478:	+37314	−.074:
	1960	37 018.525	+41066	−.088
	1962	37 791.426	+43707	−.102

Var 87 The star is of RRc type, close to the centre, therefore the scatter is considerable and the observations are systematically too high. The small range increases the uncertainty in determining the epochs. Bakers's observations are of poor quality. Larink's maximum at J. D. 2422756.55 is extremely low. The differences in Müller's maxima and ascending branches suggest variations of the light curve. Because of the considerable scatter in our observations we can make no conclusions about eventual light curve changes. The O−C values preceding Larink are uncertain. The (O−C)-s were calculated with the formula:

$$C = 2425000.037 + 0^d.3574814 \;\; E.$$

Observer	Year	t(med)hel.	E	O−C
B	1900	J. D. 2415 161.796:	−27521	+^{d}.005:
L	1921	22 761.526	− 6262	+.036
M	1925	24 290.454	− 1985	+.018
G	1926	24 683.674	− 885	+.008
Bp	1940	29 720.562:	+13205	−.017:
Ma	1940	29 770.283:	+13344	+.014:
Bp	1941	30 078.411	+14206	−.007
	1950	33 420.506	+23555	−.005
	1952	34 121.526	+25516	−.006
RS	1953	34 482.955	+26527	+.009
Bp	1955	35 224.387:	+28601	+.024:
	1956	35 600.444	+29653	+.011
	1960	36 991.481:	+33544	+.088:
	1962	37 791.453	+35782	+.017

Var 88 The star is of the RRc type. It is situated very near the centre. The observations therefore exhibit considerable errors and the observations are systematically brighter. Martin's epoch deviates considerably from our O—C diagram. We are in need of the Mt. Wilson material of 1912 and 1915. The O—C diagram covering an interval longer than 60 years can be represented by a single large sinusoidal wave. The residuals were computed with the formula:

$$C = 2425000.125 + 0\overset{d}{.}2985092\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 078.524:	—36587	—^{d}045:
	1900	15 161.780	—32958	—.079
L	1921	22 761.550	— 7499	—.055
M	1925	24 288.466	— 2384	—.013
G	1926	24 683.708	— 1060	+.003
Bp	1940	29 720.558:	+15813	+.107:
Ma	1940	29 770.158:	+15979	+.154:
Bp	1941	30 078.458	+17012	+.094
	1950	33 421.453	+28211	+.085
	1951	33 763.543:	+29357	+.083:
	1952	34 121.431	+30556	+.059
	1953	34 487.408	+31782	+.064
	1955	35 223.502	+34248	+.034
	1956	35 603.511	+35521	+.041
	1957	35 920.487:	+36583	.000:
	1960	37 018.390	+40261	—.014
	1962	37 791.499	+42851	—.044

Var 89 The hump in the ascending branch is well pronounced. The O—C diagram represents a part of a long sinusoidal wave. The star is close to the centre, therefore the brightness data are systematically higher. The O—C diagram is constructed with the formula:

$$C = 2425000.487 + 0\overset{d}{.}5484779\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1900	J. D. 2415 160.779	—17940	—^{d}014
L	1921	22 761.597	— 4082	—.003
M	1925	24 292.402	— 1291	.000
G	1926	24 647.815	— 643	—.001
Ma	1940	29 770.064	+ 8696	+.013
Bp	1941	30 078.309:	+ 9258	+.014:
	1950	33 390.562	+15297	+.009
	1951	33 763.529	+15977	+.011
	1952	34 118.388	+16624	+.004
	1953	34 487.518	+17297	+.009
	1955	35 223.570	+18639	+.003
	1956	35 600.374	+19326	+.003
	1962	37 791.538	+23321	—.002

Var 90 The scatter in minimum is considerable. The residuals O—C outline a sinusoidal wave of small range. The residuals are computed with the formula:

$$C = 2425000.182 + 0^d.5170334\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 384.501:	−22466	−^{d}.009:
	1896	13 691.619:	−21872	−.008:
	1899	14 841.496:	−19648	−.014:
H	1912	19 479.827:	−10677	+.011:
	1915	20 625.573:	− 8461	+.011:
L	1921	22 761.437	− 4330	+.010
M	1925	24 309.434	− 1336	+.009
G	1926	24 683.761	− 612	+.003
Sch	1938	28 965.826:	+ 7670	−.002:
H	1939	29 431.669	+ 8571	−.006
Ma	1940	29 770.329	+ 9226	−.003
Bp	1941	30 078.479	+ 9822	−.005
Be	1946	31 968.751	+13478	−.007
	1948	32 683.804:	+14861	−.011:
Bp	1950	33 390.595:	+16228	−.005:
	1951	33 763.373:	+16949	−.008:
	1952	34 118.576:	+17636	−.007:
RS	1953	34 447.918	+18273	−.015
Bp	1955	35 223.473	+19773	−.010
	1956	35 600.392	+20502	−.009
	1957	35 920.433:	+21121	−.011:
	1960	37 018.621:	+23245	−.002:
	1962	37 791.584:	+24740	−.004:

Var 91 Small variations of the light curve are probable. The Budapest material contains no maxima, only a few rising branches. A positive parabola represents a good approximation to the O−C diagram. The diagram is constructed using the formula:

$$C = 2425000.100 + 0^d.5301630\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 383.490:	−21911	−^{d}209:
	1896	13 692.629:	−21328	−.155:
	1897	14 079.630:	−20598	−.173:
	1898	14 437.517:	−19923	−.146:
	1899	14 841.513	−19161	−.134
	1900	15 161.731	−18557	−.134
L	1921	22 756.447	− 4232	−.003
M	1925	24 312.462	− 1297	−.016
Ma	1940	29 770.473	+ 8998	−.034
Bp	1940	29 775.264:	+ 9007	−.014:
	1941	30 078.525	+ 9579	−.006
	1950	33 390.372:	+15826	−.088:
	1952	34 121.431	+17205	−.123
	1953	34 487.244:	+17895	−.123:
	1955	35 227.338:	+19291	−.136:
	1956	35 603.221:	+20000	−.139:
	1957	35 933.487	+20623	−.165
	1960	37 058.474:	+22745	−.183:
	1962	37 791.144:	+24127	−.199:

Var 92 Small variations of the light curve can be established with certainty. Larink's rising branch of J. D. 2422730.5 is extremely steep, while Müller obtained rising branches with small slope. Similarly Belserene's rising branches of 1946 have slighter slopes than those of 1948. The phase shift of the maxima has an amplitude of about $0^h.15$ according to Budapest material. The scatter in the O—C diagram is caused by the light curve variations. The diagram is constructed using the formula:

$$C = 2425000.050 + 0^d.5035553\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1896	J. D. 2413 691.670:	—22457	—^{d}.039:
	1897	14 036.595:	—21772	—.049:
	1898	14 456.576:	—20938	—.043:
H	1915	20 625.669	— 8687	+.004
L	1921	22 730.517	— 4507	—.009
M	1925	24 290.539	— 1409	—.002
S	1926	24 621.880	— 751	.000
G	1926	24 684.828	— 626	+.004
Bp	1938	28 991.209:	+ 7926	—.020:
H	1939	29 404.646	+ 8747	—.002
Ma	1940	29 770.205	+ 9473	—.024
Bp	1941	30 078.403:	+10085	—.002:
Be	1946	31 971.745	+13845	—.028
	1948	32 684.777	+15261	—.030
Bp	1950	33 421.487	+16724	—.022
	1951	33 763.385	+17403	—.038
	1952	34 121.432	+18114	—.019
	1953	34 487.495	+18841	—.040
	1956	35 603.371	+21057	—.043
	1960	37 018.378:	+23867	—.026:
	1962	37 791.335:	+25402	—.027:

Var 93 The hump in the ascending branch is well pronounced and lasts about $0^h.5$. The diagram is computed with the ephemeris:

$$C = 2425000.093 + 0^d.6022991\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 078.534:	—18133	—^{d}.069:
	1899	14 841.610:	—16866	—.106:
	1900	15 160.850	—16336	—.085
H	1912	19 479.946	— 9165	—.076
	1915	20 626.749:	— 7261	—.050:
L	1921	22 756.530	— 3725	+.001
M	1925	24 298.419	— 1165	+.004
S	1926	24 621.851	— 628	+.002
G	1926	24 647.745	— 585	—.003
Sch	1938	28 983.693:	+ 6614	—.006:
Bp	1938	28 991.527	+ 6627	—.002
H	1939	29 407.724	+ 7318	+.006
Ma	1940	29 770.305	+ 7920	+.003
Be	1946	31 971.703	+11575	—.002

Observer	Year	t(med)hel.	E	O−C
Be	1948	J. D. 2432 683.622:	+12757	−^{d}001:
Bp	1950	33 421.443	+13982	+.004
	1952	34 118.297:	+15139	−.002:
RS	1953	34 482.681	+15744	−.009
Bp	1953	34 487.507	+15752	−.001
	1955	35 223.516	+16974	−.002
	1960	37 057.523	+20019	+.004
	1962	37 791.121:	+21237	+.002:

Var 94 Unfortunately, the Budapest material does not contain maxima and well observed rising branches. Therefore the light curve is uncertain. After all, the variable is a simple one, having a straight line for its O−C diagram. The diagram is constructed with the formula:

$$C = 2425000.049 + 0^{d}.5236937\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 383.480:	−22182	+^{d}007:
	1897	14 080.510:	−20851	−.002:
H	1912	19 534.778:	−10436	−.004:
	1915	20 625.620:	− 8353	−.016:
L	1921	22 756.544	− 4284	−.001
M	1925	24 289.401	− 1357	+.004
S	1926	24 620.894	− 724	−.001
G	1926	24 683.738	− 604	.000
Bp	1938	28 963.369:	+ 7568	+.006:
Sch	1938	28 983.780:	+ 7607	−.007:
H	1939	29 367.654	+ 8340	.000
Bp	1940	29 719.568	+ 9012	−.009
Ma	1940	29 770.373	+ 9109	−.002
Bp	1941	30 078.307:	+ 9697	.000:
Be	1946	31 966.749	+13303	+.003
	1948	32 683.682	+14672	−.001
Bp	1950	33 420.528	+16079	+.008
	1952	34 122.271:	+17419	+.001:
	1953	34 487.284:	+18116	.000:
RS	1953	34 508.755	+18157	−.001
Bp	1956	35 603.275:	+20247	.000:
	1960	37 057.573	+23024	.000
	1962	37 791.272:	+24425	+.004:

Var 96 The period is nearly half a day, therefore, in some years the observations do not contain rising branches. The period decreases rather rapidly. The residuals are calculated with the formula:

$$C = 2425000.059 + 0^{d}.4994467\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1900	J. D. 2415 161.835	−19698	−^{d}123
L	1921	22 761.537	− 4482	−.002
G	1926	24 647.946	− 705	−.003

Observer	Year	t(med)hel.	E	O−C
Ma	1940	J. D. 2429 770.243	+ 9551	−^{d}031
Bp	1940	29 774.244:	+ 9559	−.026:
	1941	30 078.401:	+10168	−.032:
Be	1946	31 968.775	+13953	−.064
Bp	1951	33 763.252:	+17546	−.099:
	1952	34 118.347	+18257	−.110
RS	1953	34 482.932	+18987	−.121
Bp	1953	34 487.431	+18996	−.118
	1955	35 227.593	+20478	−.136
	1960	37 018.564	+24064	−.180
	1962	37 791.179:	+25611	−.209:

Var 97 The star is of RRc-type. Small irregularities are possible, a slow increase of the period is certain. The residuals O−C are calculated with the formula:

$$C = 2425000.266 + 0^{d}.3349289\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1900	J. D. 2415 161.759	−29375	+^{d}025
H	1912	19 479.963	−16482	−.005
	1915	20 625.760	−13061	.000
L	1921	22 760.601	− 6687	+.005
M	1925	24 287.533	− 2128	−.004
S	1926	24 620.803	− 1133	+.011
G	1926	24 683.761	− 945	+.003
Sch	1938	28 964.832:	+11837	+.013:
Bp	1938	28 991.635:	+11917	+.021:
H	1939	29 431.723	+13231	+.013
Ma	1940	29 770.320	+14242	−.003
Bp	1940	29 775.353:	+14257	+.006:
	1941	30 078.464	+15162	+.006
Be	1946	31 969.811	+20809	+.010
	1948	32 683.884:	+22941	+.014:
Bp	1950	33 422.405	+25146	+.017
	1951	33 763.358:	+26164	+.012:
	1952	34 118.382	+27224	+.012
RS	1953	34 483.796	+28315	+.018
Bp	1953	34 487.485	+28326	+.023
	1955	35 224.344:	+30526	+.038:
	1956	35 600.459	+31649	+.028
	1957	35 933.393:	+32643	+.043:
	1960	37 018.553	+35883	+.033
	1962	37 791.577	+38191	+.041

Var 99 The period is probably about half a day, its variation is certain.

Var 100 The star is close to the centre, therefore, the observations are systematically high and their scatter is large. The errors of the epochs are increased by the fact that the ascending branch is flat, the amplitude small. The scatter in the O−C diagram arises from these circumstances. The (O−C)-s are computed with the formula:

$$C = 2425000.074 + 0^d\!.6188126\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 390.520:	—18761	—^{d}.011:
	1898	14 437.549:	—17069	—.013:
L	1921	22 760.602	— 3619	+.011
M	1925	24 309.479	— 1116	.000
G	1926	24 647.958:	— 569	—.012:
Ma	1940	29 770.501	+ 7709	+.001
Bp	1940	29 775.450	+ 7717	—.001
	1950	33 421.481	+13609	—.014
	1952	34 118.271:	+14735	—.007:
	1955	35 223.464	+16521	—.013
	1956	35 603.414	+17135	—.014
	1960	36 991.426:	+19378	+.001:
	1962	37 791.540	+20671	—.009

Var 101 The star is very close to the centre, the scatter is very significant. Furthermore the amplitude is very small and the ascending branch flat. The epochs may contain errors amounting to $0^d\!.01$. The brightness data exceed the average values. The residuals O—C are computed with the formula:

$$C = 2425000.204 + 0^d\!.6438975\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1900	J. D. 2415 160.777	—15281	—^{d}.029
L	1921	22 730.500:	— 3525	+.035:
M	1925	24 287.420	— 1107	+.011
G	1926	24 684.677	— 490	—.017
Bp	1940	29 720.575:	+ 7331	—.042:
Ma	1940	29 770.19 :	+ 7408	—.007:
Bp	1950	33 420.459	+13077	+.007
	1952	34 118.397	+14161	—.039
	1953	34 487.353	+14734	—.037
	1955	35 223.357:	+15877	—.008:
	1956	35 603.232:	+16467	—.032:
	1960	37 018.528:	+18665	—.023:

Var 102 If the star is variable at all, only variations within the limits of the scatter are possible. The amplitude cannot exceed $0^m\!.1$. The brightness of the star is about $15^m\!.8$. Perhaps colour measurements could decide the question of variability.

Var 104 The star lies near the centre and has close companions. Hence the errors of the observations are considerable. On many plates the object was unmeasurable. The large deviation for the 1950 (O—C) value in Fig. 58 is real. Perhaps the O—C diagram should have been approximated by cycles and not by a parabola. The diagram was constructed using the formula:

$$C = 2425000.043 + 0^{d}.5699231\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 078.585:	−19163	$-^{d}.022$:
	1900	15 160.887:	−17264	−.004:
L	1921	22 733.460	− 3977	+.001
M	1925	24 298.462	− 1231	−.006
G	1926	24 683.739	− 555	+.003
Ma	1940	29 770.294	+ 8370	−.005
Bp	1940	29 775.431	+ 8379	+.002
	1941	30 052.406:	+ 8865	−.005:
	1950	33 422.381	+14778	+.014
	1952	34 120.514:	+16003	−.008:
	1955	35 224.446	+17940	−.017
	1956	35 603.446	+18605	−.016
	1957	35 933.434	+19184	−.014
	1960	37 018.566	+21088	−.015
	1962	37 791.384	+22444	−.013

Var 105 The star is of RRc-type. The Budapest mean light curve suggests a double maximum, while Belserene's and Roberts and Sandage's observations do not show this phenomenon. The variable is of very small range and has a short period. The part of the O—C diagram preceding Larink's observations is uncertain, the Mt. Wilson material of 1912 and 1915 would be of great importance. The O—C diagram is a superposition of waves with different amplitudes and lengths, which seems to be a characteristic feature of the RRc variables. The residuals O—C were computed with the formula:

$$C = 2425000.220 + 0^{d}.2877427\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1899	J. D. 2414 841.444:	−35305	$-^{d}.020$:
L	1921	22 730.525	− 7888	+.019
M	1925	24 298.431	− 2439	+.015
S	1926	24 642.860	− 1242	+.016
G	1926	24 647.746	− 1225	+.011
Sch	1938	28 966.738:	+13785	−.015:
Ma	1940	29 770.124	+16577	−.007
Bp	1940	29 774.436:	+16592	−.011:
Be	1946	31 974.831	+24239	+.016
	1948	32 684.697:	+26706	+.020:
Bp	1950	33 422.468	+29270	+.019
	1951	33 763.437	+30455	+.013
	1952	34 118.513	+31689	+.015
	1953	34 487.406	+32971	+.021
RS	1953	34 508.689	+33045	+.013
Bp	1955	35 223.442	+35529	+.012
	1956	35 600.392	+36839	+.019
	1957	35 933.602:	+37997	+.023:
	1960	37 057.529	+41903	+.027
	1962	37 791.563	+44454	+.029

Var 106 The light curve is varying, but only in a small extent, hence normal points can be constructed along the entire light curve. The maximum on J. D. 2434121 is lower than the other ones and the ascending branch preced-

ing this maximum has the least slope in the material. The maximum on J. D. 2437791 is probably high. The height of the maximum oscillates with an amplitude of about 0^m25. The part of the O—C diagram preceding Larink's observations is uncertain, the Mt. Wilson magnitudes of 1912 and 1915 would be very important. The residuals O—C are computed with the formula:

$$C = 2425000.437 + 0^d5471593\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 691.647:	—20668	—^{d}102:
	1897	14 067.560	—19981	—.087
	1898	14 456.591:	—19270	—.086:
	1900	15 160.793	—17983	—.078
L	1921	22 761.445	— 4092	—.016
M	1925	24 292.408	— 1294	—.005
S	1926	24 621.803	— 692	.000
G	1926	24 684.724	— 577	—.002
B	1938	28 963.468:	+ 7243	—.044:
Ma	1940	29 770.522	+ 8718	—.050
Bp	1940	29 775.456:	+ 8727	—.040:
	1950	33 390.526	+15334	—.052
	1951	33 763.133:	+16015	—.060:
	1952	34 121.520	+16670	—.063
	1955	35 223.485	+18684	—.076
	1956	35 600.463:	+19373	—.091:
	1957	35 920.554	+19958	—.088
	1960	37 057.540	+22036	—.099

Var 107 The star is of RRc-type. The O—C diagram consists of several cycles with nearly equal length and amplitude. The (O—C)-s are calculated with the formula:

$$C = 2425000.122 + 0^d3090351\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 383.488:	—37590	—^{d}005:
	1896	13 664.709:	—36680	—.006:
	1897	14 077.579:	—35344	—.006:
	1899	14 841.505:	—32872	—.015:
	1900	15 160.742:	—31839	—.011:
H	1912	19 534.849:	—17685	+.013:
	1915	20 654.787	—14061	+.008
L	1921	22 730.568	— 7344	.000
M	1925	24 286.551	— 2309	—.009
S	1926	24 621.856	— 1224	—.007
G	1926	24 647.813	— 1140	—.009
Bp	1938	28 963.486:	+12825	—.011:
Sch	1938	28 983.874:	+12891	—.019:
H	1939	29 367.704	+14133	—.011
Ma	1940	29 770.054	+15435	—.025
Bp	1940	29 774.385:	+15449	—.020:
	1941	30 078.475	+16433	—.021
Be	1946	31 965.761	+22540	—.012
	1948	32 684.886:	+24867	—.012:

Observer	Year	t(med)hel.	E	O—C
Bp	1950	J. D. 2433 420.403:	+27247	+^{d}002:
	1951	33 763.430	+28357	.000
	1952	34 121.599	+29516	—.003
RS	1953	34 483.782	+30688	—.009
Bp	1953	34 487.491	+30700	—.009
	1955	35 224.541	+33085	—.007
	1956	35 603.415	+34311	—.010
	1957	35 920.483	+35337	—.012
	1960	37 018.485	+38890	—.012
	1962	37 791.390	+41391	—.004

Var 108 The Budapest material contains only a few median points on the ascending branch and only two maxima. The residuals O—C are calculated with the formula:

$$C = 2425000.037 + 0^{d}.5196049\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 079.520:	—21017	+^{d}019:
	1900	15 160.827	—18936	+.028
H	1912	19 534.842	—10518	+.009
L	1921	22 761.581	— 4308	+.002
M	1925	24 309.481	— 1329	—.001
S	1926	24 621.763	— 728	—.002
G	1926	24 647.747	— 678	+.002
Sch	1938	28 966.715:	+ 7634	+.014:
H	1939	29 430.727	+ 8527	+.019
Ma	1940	29 770.030	+ 9180	+.020
Be	1946	31 973.680	+13421	+.026
	1948	32 700.607:	+14820	+.025:
Bp	1950	33 422.337:	+16209	+.024:
	1952	34 121.209:	+17554	+.028:
	1953	34 487.522:	+18259	+.019:
RS	1953	34 507.793	+18298	+.026
Bp	1955	35 227.455:	+19683	+.035:
	1956	35 600.525	+20401	+.028
	1957	35 933.594	+21042	+.031
	1960	37 018.534	+23130	+.036
	1962	37 791.201:	+24617	+.050:

Var 109 The star is very close to the centre. The brightness data are systematically higher, the scatter is very considerable. The O—C diagram consists of small cycles. Its course preceding Larink's observations is uncertain. The (O—C)-s are calculated with the formula:

$$C = 2425000.062 + 0^{d}.5339239\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 384.534:	—21755	—^{d}014:
	1897	14 078.624:	—20455	—.025:
L	1921	22 756.533:	— 4202	+.019:

Observer	Year	t(med)hel.	E	O—C
M	1925	J. D. 2424 289.409	— 1331	^{d}000
G	1926	24 647.673	— 660	+.001
Ma	1940	29 770.143	+ 8934	+.005
Bp	1940	29 774.415	+ 8942	+.005
	1951	33 763.335:	+16413	—.020:
	1952	34 120.534	+17082	—.016
	1953	34 487.337	+17769	—.019
	1956	35 598.438:	+19850	—.013:
	1960	36 991.450:	+22459	—.009:

Var 110 The differences in the height of maximum amounting to $0^{m}_{.}4$ are real. The star is very close to the centre, therefore, the scatter is very large. Normal points are constructed along the entire light curve. The O—C diagram is extremely complicated, the curve drawn in the figure, however, seems very probable. The Mt. Wilson material of 1912 and 1915, further of 1946 and 1948 would be of great importance. The O—C diagram is constructed with the ephemeris:

$$C = 2425000.440 + 0^{d}_{.}5353569\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 383.523:	—21700	+^{d}328:
	1896	13 724.495:	—21063	+.277:
	1897	14 074.573:	—20409	+.232:
	1898	14 437.550:	—19731	+.237:
	1900	15 160.767	—18380	+.187
L	1921	22 761.412:	— 4182	—.165:
M	1925	24 313.462	— 1283	—.115
S	1926	24 642.769	— 668	—.053
Bp	1938	28 991.404	+ 7454	+.414
	1939	29 346.392:	+ 8117	+.460:
Ma	1940	29 770.462	+ 8909	+.527
Bp	1941	30 078.341:	+ 9484	+.576:
	1950	33 422.491	+15731	+.352
	1951	33 763.500:	+16368	+.338:
	1952	34 120.528	+17035	+.283
	1955	35 227.513:	+19103	+.150:
	1956	35 603.260:	+19805	+.077:
	1957	35 933.497	+20422	—.002
	1960	37 018.589:	+22449	—.078:
	1962	37 791.558	+23893	—.164

Var 113 The Budapest material contains only a few badly defined rising branches, most of the observations having been obtained on the descending branch. Very steep ascending and descending branches are characteristic for the light curve.

The O—C values have been computed by the formula:

$$C = 2425000.187 + 0^{d}.5130066\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 071.635:	−21303	$+^{d}.028$:
	1900	15 161.770	−19178	+.024
L	1921	22 729.603	− 4426	−.017
M	1925	24 286.570	− 1391	−.025
G	1926	24 647.724	− 687	−.027
Ma	1940	29 770.106	+ 9298	−.016
Bp	1941	30 078.425	+ 9899	−.014
	1950	33 390.422	+16355	+.012
	1951	33 763.379:	+17082	+.013:
	1952	34 121.458:	+17780	+.014:
	1955	35 223.399:	+19928	+.016:
	1956	35 600.463:	+20663	+.021:
	1957	35 920.580	+21287	+.022
	1960	37 018.424:	+23427	+.031:
	1962	37 791.522	+24934	+.028

Var 114 The Budapest material contains only a few rising branches of poor quality. The O—C diagram is a straight line, but small oscillations may be superposed. The residuals are computed with the formula:

$$C = 2425000.513 + 0^{d}.5977270\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1897	J. D. 2414 077.671:	−18274	$+^{d}.021$:
	1898	14 437.502:	−17672	+.021:
	1899	14 841.546	−16996	+.001
	1900	15 160.724:	−16462	−.007:
L	1921	22 761.436	− 3746	+.008
M	1925	24 290.411	− 1188	−.002
G	1926	24 683.713	− 530	−.005
Bp	1938	28 991.530:	+ 6677	−.006:
Ma	1940	29 770.374	+ 7980	.000
Bp	1941	30 052.502	+ 8452	.000
	1950	33 422.484	+14090	−.002
	1952	34 122.428	+15261	+.003
	1955	35 223.439	+17103	+.001
	1957	35 920.395:	+18269	+.007:
	1960	37 018.411	+20106	−.001
	1962	37 791.282:	+21399	+.009:

Var 115 The star is very far from the centre of the cluster. The O—C diagram is a parabola with a slight negative curvature on which the scatter or real oscillations are superposed. The residuals are computed with the formula:

$$C = 2425000.347 + 0^{d}.5133529\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 377.518	−22641	$-^{d}.006$
	1897	14 073.617:	−21285	−.014:
	1898	14 456.589:	−20539	−.003:

Observer	Year	t(med)hel.	E	O—C
B	1899	J. D. 2414 841.592	—19789	—$^d_.$014
L	1921	22 760.593	— 4363	+.005
M	1925	24 291.401	— 1381	—.006
G	1926	24 647.677	— 687	+.003
Bp	1939	29 346.387	+ 8466	—.006
	1940	29 719.601:	+ 9193	+.001:
Ma	1940	29 770.419	+ 9292	—.003
Bp	1941	30 078.427	+ 9892	—.007
	1950	33 390.581	+16344	—.006
	1951	33 763.268:	+17070	—.013:
	1952	34 120.569	+17766	—.006
	1955	35 223.252:	+19914	—.005:
	1956	35 598.510	+20645	—.008
	1960	37 018.431:	+23411	—.021:
	1962	37 791.545	+24917	—.016

Var 116 The light curve and the O—C diagram are similar to those of var 113. Also the periods are nearly equal. Both variables are situated at nearly equal distances from the centre but approximately in opposite directions. The (O—C)-s are calculated with the formula:

$$C = 2425000.491 + 0^d_.5148088 \text{ E}.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 389.532:	—22554	+$^d_.$039:
	1897	14 067.534:	—21237	+.037:
L	1921	22 756.452	— 4359	+.013
M	1925	24 288.512	— 1383	+.002
S	1926	24 642.701	— 695	+.002
Bp	1938	28 963.495:	+ 7698	+.006:
Ma	1940	29 770.195	+ 9265	.000
Bp	1940	29 775.340:	+ 9275	—.003:
	1941	30 052.312:	+ 9813	+.002:
	1950	33 390.353:	+16297	+.023:
	1952	34 121.381	+17717	+.022
	1953	34 487.412	+18428	+.024
	1956	35 600.435	+20590	+.031
	1957	35 933.513	+21237	+.028
	1960	36.991.449	+23292	+.031
	1962	37 791.467	+24846	+.037

Var 117 The light curve exhibits strong variations with differences in the height of maximum of $0^m_.45$ at least. Unfortunately, the Budapest material does not contain maxima well covered with observations, therefore only normal points are given along the entire light curve. The amplitude of the oscillations of the median point on the rising branch can be put at $0^h_.3$. The O—C residuals are calculated with the formula:

$$C = 2425000.250 + 0^d\!.6005164\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 372.531:	—19363	$+^d$080:
	1897	14 080.525	—18184	+.065
	1900	15 160.864:	—16385	+.075:
H	1915	20 656.730:	— 7233	+.015:
L	1921	22 761.527	— 3728	+.002
M	1925	24 290.439	— 1182	—.001
		24 311.470	— 1147	+.012
G	1926	24 647.742	— 575	—.005
Sch	1938	28 964.877:	+ 6602	+.018:
H	1939	29 408.666	+ 7341	+.025
Ma	1940	29 770.185	+ 7943	+.033
Bp	1940	29 774.384:	+ 7950	+.029:
	1941	30 052.448:	+ 8413	+.054:
Be	1946	31 968.693	+11604	+.051
	1948	32 700.749	+12823	+.077
Bp	1950	33 421.361:	+14023	+.070:
	1952	34 121.552	+15189	+.058
RS	1953	34 507.694	+15832	+.068
Bp	1955	35 223.518	+17024	+.077
	1960	37 018.469:	+20013	+.084:

Var 118 The period is about $0^d\!.5$, but by lucky chance a lot of well observed ascending branches are obtained. As O—C diagram a parabola is drawn, but perhaps a sinusoidal wave would fit the observations better. The residuals are computed with the formula:

$$C = 2425000.355 + 0^d\!.4993807\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1899	J. D. 2414 841.475	—20343	$+^d$022
H	1915	20 625.777	— 8760	—.003
L	1921	22 760.635	— 4485	+.002
G	1926	24 647.795	— 706	+.003
Bp	1938	28 991.406	+ 7992	.000
Ma	1940	29 770.443	+ 9552	+.004
Bp	1940	29 775.439	+ 9562	+.006
Be	1946	31 971.717	+13960	+.007
	1948	32 682.837:	+15384	+.009:
Bp	1950	33 421.420	+16863	+.008
	1951	33 763.495	+17548	+.007
	1952	34 120.554	+18263	+.009
	1960	37 018.467	+24066	+.016
	1962	37 791.519	+25614	+.027

Var 119 The O—C diagram is composed of waves of different length and amplitude. Perhaps the residuals obtained from Baker's observations have to be shifted by 1P downwards. The (O—C)-s are calculated with the data:

$$C = 2425000.333 + 0^d.5177404\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1895	J. D. 2413 390.522:	−22424	^{d}.000:
	1897	14 078.610:	−21095	+.011:
	1898	14 456.566:	−20365	+.016:
	1899	14 807.604:	−19687	+.026:
	1900	15 161.755	−19003	+.043
H	1915	20 654.877:	− 8393	−.061:
L	1921	22 730.514	− 4384	−.045
M	1925	24 288.430	− 1375	−.010
G	1926	24 647.747	− 681	−.005
H	1939	29 431.684	+ 8559	+.011
Ma	1940	29 770.287	+ 9213	+.012
Bp	1941	30 052.451	+ 9758	+.007
Be	1946	31 974.821	+13471	+.007
	1948	32 700.692	+14873	+.006
Bp	1950	33 422.429	+16267	+.013
	1952	34 122.417	+17619	+.016
RS	1953	35 482.766	+18315	+.018
Bp	1953	34 487.431	+18324	+.023
	1956	35 598.493	+20470	+.014
	1957	35 933.464	+21117	+.007
	1960	37 018.644:	+23213	+.003:

Var 120 The star has a very flat ascending branch, therefor the scatter obtained in the O−C diagram exceeds the average. The diagram is a straight line, although different oscillations may be superposed. It is constructed with the formula:

$$C = 2425000.350 + 0^d.6401387\ E.$$

Observer	Year	t(med)hel.	E	O−C
B	1896	J. D. 2413 691.657:	−17666	−^{d}.003:
	1900	15 160.791	−15371	+.013
H	1915	20 625.652:	− 6834	+.010:
L	1921	22 760.491	− 3499	−.014
M	1925	24 290.443	− 1109	+.007
S	1926	24 565.033	− 680	−.023
G	1926	24 684.741:	− 493	−.021:
Bp	1938	28 963.459:	+ 6191	+.010:
H	1939	29 400.669	+ 6874	+.006
Ma	1940	29 770.043	+ 7451	+.020
Be	1946	31 974.668	+10895	+.007
Bp	1950	33 421.366	+13155	−.009
	1952	34 118.486	+14244	.000
	1953	34 487.207:	+14820	+.001:
RS	1953	34 507.684	+14852	−.006
Bp	1955	35 223.366	+15970	+.001
	1956	35 600.415	+16559	+.008
	1957	35 920.467:	+17059	−.009:
	1960	37 018.312:	+18774	−.002:

Var 121 The light curve is strongly variable, with phase-shifts exceeding $0^h.8$! The variable is very close to the centre, therefore, the scatter is very large

and the magnitude scale in the light curve is distorted. The (O—C)-s are calculated with the formula:

$$C = 2425000.289 + 0\overset{d}{.}5351882\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 077.647:	—20409	+$\overset{d}{.}$014:
	1900	15 160.879:	—18385	+.025:
L	1921	22 730.559	— 4241	+.003
		22 760.508	— 4185	—.018
M	1925	24 311.500	— 1287	—.002
S	1926	24 621.900	— 707	—.011
Ma	1940	29 770.43 :	+ 8913	+.009:
Bp	1941	30 052.508:	+ 9440	+.042:
	1950	33 421.464	+15735	—.011
	1951	33 763.501	+16374	+.040
	1952	34 121.479	+17043	—.022
	1955	35 223.470	+19102	+.016
	1956	35 603.444	+19812	+.006
	1960	37 018.465:	+22456	—.010:
	1962	37 791.287:	+23900	.000:

Var 123 This variable has in our material the greatest distance from the centre of the cluster. The residuals preceding Larink's observations provide an uncertain section of the O—C diagram. The diagram is constructed with the formula:

$$C = 2425000.210 + 0\overset{d}{.}5454472\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 691.553:	—20733	+$\overset{d}{.}$100:
L	1921	22 760.629	— 4106	+.025
M	1925	24 289.508	— 1303	+.016
G	1926	24 647.854	— 646	+.003
Bp	1938	28 991.211:	+ 7317	—.036:
Ma	1940	29 770.115	+ 8745	—.031
Bp	1941	30 078.314:	+ 9310	—.009:
	1950	33 422.510	+15441	+.050
	1951	33 763.419	+16066	+.054
	1952	34 118.510	+16717	+.059
	1955	35 227.411:	+18750	+.066:
	1956	35 600.509	+19434	+.078
	1960	37 057.413:	+22105	+.093:
	1962	37 791.575:	+23451	+.083:

Var 124 All observers got considerable scatter for this variable. The star has a flat ascending branch, therefore, the errors of the O—C values exceed the average. The diagram consists of a large sinusoidal wave. According to the characteristics of its light curve, the star behaves similar to RRab stars having periods shorter by about $0\overset{d}{.}1$. (The star belongs to the long period sequence.) The O—C values are calculated using the formula:

$$C = 2425000.712 + 0^d.7524328\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1896	J. D. 2413 691.648:	—15030	+^{d}.001:
	1897	14 077.649:	—14517	+.004:
L	1921	22 761.445	— 2976	—.027
M	1925	24 290.421	— 944	+.004
G	1926	24 647.816	— 469	—.005
Ma	1940	29 770.421	+ 6339	+.037
Bp	1940	29 774.187:	+ 6344	+.041:
	1941	30 078.176:	+ 6748	+.047:
	1950	33 420.461	+11190	+.026
	1952	34 120.243:	+12120	+.045:
	1953	34 487.413	+12608	+.028
RS	1953	34 507.719	+12635	+.019
Bp	1955	35 223.270	+13586	+.006
	1957	35 933.565:	+14530	+.004:
	1960	37 018.549:	+15973	—.020:
	1962	37 791.310:	+16999	—.007:

Var 125 The star is of RRc type. Phase-oscillations from epoch to epoch amounting to several minutes can be clearly seen in the material of almost every observer. The (O—C)-s are calculated using the formula:

$$C = 2425000.295 + 0^d.3498206\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 077.547	—31224	+^{d}.050
H	1915	20 654.835	—12422	+.011
L	1921	22 756.540	— 6414	—.006
M	1925	24 290.515	— 2029	+.006
G	1926	24 684.750	— 902	—.007
Sch	1938	28 966.556:	+11338	—.005:
Bp	1938	28 991.397:	+11409	—.001:
H	1939	29 408.743	+12602	+.009
Ma	1940	29 770.117	+13635	+.018
Bp	1941	30 078.295:	+14516	+.004:
Be	1946	31 968.744	+19920	+.023
	1948	32 683.807:	+21964	+.052:
Bp	1950	33 420.516	+24070	+.039
	1951	33 763.340:	+25050	+.039:
	1952	34 120.509	+26071	+.041
	1953	34 487.465:	+27120	+.035:
RS	1953	34 507.753	+27178	+.034
Bp	1955	35 224.540	+29227	+.038
	1956	35 603.410	+30310	+.053
	1960	37 018.436	+34355	+.054
	1962	37 791.545	+36565	+.060

Var 126 The star is of RRc-type. Larink's observations show differences in the height of maximum amounting to $0^m.5$. There is a low, flat maximum on J. D. 2422756.5, while the maxima on J. D. 2422729.6 and J. D. 2422761.4 are high. (The maximum on J. D. 2422840 may be even higher.) Müller's material shows the same phenomena. The heights of the maxima on J. D. 2424289.5, J. D. 2424290.5 and J. D. 2424298.5 are different. Furthermore, phase-shifts

of several minutes can be detected from epoch to epoch. On the other hand Greenstein's and Roberts—Sandage's observations and the Budapest material do not show any light curve variations. The O—C diagram consists of waves of nearly equal length and amplitude, its section preceding Larink's observations is uncertain. The Mt. Wilson material of 1912 and 1915 would be of great importance. The O—C diagram is constructed with the formula:

$$C = 2425000.164 + 0\overset{d}{.}3484043\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1895	J. D. 2413 372.523:	—33374	+^{d}.004:
L	1921	22 760.633:	— 6428	+.012:
M	1925	24 290.465	— 2037	+.001
G	1926	24 683.817	— 908	+.004
Ma	1940	29 770.165	+13691	—.002
Bp	1941	30 078.496	+14576	—.009
	1950	33 421.460	+24171	+.016
	1951	33 763.240:	+25152	+.011:
	1952	34 121.400	+26180	+.011
RS	1953	34 483.738	+27220	+.009
Bp	1955	35 224.451	+29346	+.014
	1956	35 603.507	+30434	+.007
	1960	37 018.370:	+34495	.000:
	1962	37 791.467	+36714	—.012

Var 131 The star is an RRc-variable, very close to the centre. Therefore the scatter is considerable. On Budapest plates of 1960 the star was not measurable at all. Larink obtained maxima of different heights, the differences amount to $0\overset{m}{.}4$. In the material of other observers such variations are not apparent. The (O—C)-s are calculated with the formula:

$$C = 2425000.158 + 0\overset{d}{.}2976919\ E.$$

Observer	Year	t(med)hel.	E	O—C
B	1897	J. D. 2414 077.594	—36691	+^{d}.050
	1898	14 456.561:	—35418	+.055:
	1900	15 161.777	—33049	+.039
L	1921	22 730.550	— 7624	—.005
M	1925	24 290.465	— 2384	+.004
S	1926	24 621.781:	— 1271	—.011:
G	1926	24 683.714	— 1063	+.002
Ma	1940	29 770.088	+16023	+.013
Bp	1940	29 775.470:	+16041	+.036:
	1941	30 078.520	+17059	+.036
	1950	33 422.518	+28292	+.061
	1951	33 763.356:	+29437	+.042:
	1952	34 121.498	+30640	+.060
	1953	34 487.363:	+31869	+.062:
	1955	35 223.536	+34342	+.043
	1956	35 603.411	+35618	+.063
	1962	37 791.446	+42968	+.062

Var 140 The star is of RRc-type. It is situated near the centre, therefore the scatter in the observations is considerable. The Budapest magnitudes obtained in the year 1962 deviate conspicuously from the averege, therefore they are omitted in constructing the normal points. Larink's material shows large irregularities, not corroborated by other observers. The O—C diagram shows considerable scatter indicating variation of the light curve. The residuals are calculated with the formula:

$$C = 2425000.123 + 0^{d}.3331304\ E$$

Observer	Year	t(med)hel.	E	C—O
L	1921	J. D. 2422 761.493	— 6720	$+^{d}.006$
M	1925	24 286.545	— 2142	—.013
G	1926	24 647.670	— 1058	—.001
Bp	1938	28 991.36 :	+11981	+.002:
Ma	1940	29 770.230	+14319	+.013
Bp	1940	29 775.207:	+14334	—.007:
	1941	30 052.401:	+15166	+.022:
	1950	33 421.343:	+25279	+.017:
	1951	33 763.466	+26306	+.015
	1952	34 121.539	+27381	—.027
RS	1953	34 483.676	+28468	—.003
Bp	1953	34 487.367:	+28479	+.023:
	1955	35 223.518	+30689	—.044
	1956	35 603.328:	+31829	—.003:
	1957	35 933.474:	+32820	+.011:
	1960	37 018.483	+36077	+.015
	1962	37 791.385:	+38397	+.054:

Var 142 The star is near the centre, the scatter of the observations is considerable. The O—C diagram can be constructed beginning with Müller's observations only, the straight line represents a good approximation. The O—C)-s are calculated with the formula:

$$C = 2425000.004 + 0^{d}.5686256\ E$$

Observer	Year	t(med)hel.	E	C—O
M	1925	J. D. 2424 287.520	— 1253	$+^{d}.004$
G	1926	24 683.843:	— 556	—.005:
Ma	1940	29 770.210	+ 8389	+.006
Bp	1941	30 078.401	+ 8931	+.002
	1950	33 422.473	+14812	—.013
	1952	34 118.484	+16036	.000
	1955	35 224.460	+17981	—.001
	1956	35 600.329:	+18642	+.007:
	1960	37 018.485	+21136	+.010
	1962	37 791.229:	+22495	—.008:

Var 202 The star is probably an RRc variable with long period.

Var 204 The variable is of very small range. Baker's corrected period (1956) satisfies the observations for every year separately, but the material of different years can not be connected. When in a year the majority of plates is of inferior quality, the whole year's material is rejected.

Table 8

Phase		m−10	n	Phase		m−10	n
V 1.				V 5.			
^{d}.011	^{p}.021	4.94	10	—	—	—	—
.030	.058	4.69	8	—	—	—	—
.050	.096	4.76	10	—	—	—	—
.074	.142	4.94	9	—	—	—	—
.093	.179	5.07	11	—	—	—	—
.113	.217	5.24	12	—	—	—	—
.134	.257	5.31	8	—	—	—	—
.155	.298	5.40	9	^{d}.192	^{p}.380	5.86	10
.179	.344	5.53	8	.216	.427	5.91	11
.197	.378	5.60	6	.240	.474	5.93	6
.223	.428	5.66	7	.269	.532	5.96	8
.250	.480	5.77	11	.290	.573	6.01	11
.279	.536	5.78	6	.315	.623	6.07	12
.313	.601	5.84	12	.341	.674	6.07	21
.351	.675	5.81	12	.368	.727	6.00	15
.397	.762	5.82	16	.391	.773	6.00	16
.437	.840	5.83	8	.418	.826	6.01	10
.472	.907	5.92	5	.443	.876	6.02	11
.495	.951	5.84	7	—	—	—	—
.514	.987	5.48	10	—	—	—	—
V 6.				V 9.			
^{d}.009	^{p}.018	5.21	12	^{d}.009	^{p}.017	5.39	2
.030	.058	4.88	5	.019	.035	5.15	3
.063	.122	5.08	12	.032	.059	4.95	1
.089	.173	5.30	10	.053	.098	5.02	7
.114	.222	5.44	11	.093	.172	5.31	10
.137	.266	5.58	12	.124	.229	5.50	11
.163	.317	5.68	13	.155	.286	5.66	13
.188	.366	5.73	15	.183	.338	5.80	17
.215	.418	5.89	12	.215	.397	5.90	14
.241	.468	5.95	11	.245	.452	6.03	17
.279	.542	5.99	7	.279	.515	6.06	20
.308	.599	6.00	7	.315	.582	6.13	13
.336	.653	6.03	11	.346	.639	6.17	11
.365	.710	6.04	8	.380	.702	6.21	15
.399	.776	5.99	9	.410	.757	6.16	13
.429	.834	5.95	13	.442	.816	6.13	15
.457	.889	6.15	14	.469	.866	6.11	18
.484	.941	6.19	9	.500	.923	6.28	8
.500	.972	5.93	8	.520	.960	6.17	3
.511	.994	5.60	4	.533	.984	5.92	6

Table 8 (continued)

V 10.

Phase		m−10	n
d.010	P.018	5.44	5
.024	.042	5.25	4
.035	.061	5.14	4
.062	.109	5.13	4
.085	.149	5.32	11
.114	.200	5.48	21
.144	.253	5.61	15
.178	.313	5.69	16
.217	.381	5.83	10
.256	.450	5.95	20
.292	.513	6.05	14
.326	.572	6.05	16
.366	.643	6.10	15
.401	.704	6.07	9
.436	.766	6.02	10
.463	.813	6.08	5
.495	.869	6.13	6
.526	.924	6.15	7
.548	.962	6.02	6
.567	.996	5.77	4

V 11.

Phase		m−10	n
d.006	P.012	5.22	10
.019	.037	4.85	11
.035	.069	4.75	17
.058	.114	4.90	19
.087	.171	5.16	13
.116	.228	5.37	10
.140	.276	5.51	12
.164	.323	5.66	12
.194	.382	5.75	12
.220	.433	5.86	3
.244	.480	5.93	3
.297	.585	6.02	3
.317	.624	6.12	4
.344	.677	6.16	5
.372	.732	6.14	7
.410	.807	6.16	9
.437	.860	6.12	17
.463	.912	6.16	19
.485	.955	6.13	16
.501	.986	5.84	9

V 12.

Phase		m−10	n
d.008	P.025	5.44	16
.024	.075	5.29	14
.039	.123	5.30	13
.055	.173	5.29	10
.071	.223	5.25	13
.087	.274	5.23	13
.104	.327	5.31	8
.118	.371	5.34	8
.133	.418	5.41	6
.149	.469	5.52	5
.169	.532	5.52	3
.185	.582	5.68	6
.200	.629	5.73	9
.216	.679	5.77	12
.231	.727	5.80	15
.245	.771	5.85	11
.263	.827	5.81	10
.278	875	5.81	11
.294	.925	5.75	13
.309	.972	3.66	14

V 13.

Phase		m−10	n
d.008	P.017	5.23	4
.022	.046	4.89	5
.038	.079	4.83	2
.062	.128	5.00	5
.082	.170	5.21	5
.105	.217	5.28	2
.127	.263	5.48	4
.155	.321	5.63	6
.188	.389	5.71	4
.212	.439	5.76	8
.242	.501	5.86	7
.277	.573	5.91	15
.308	.638	5.94	14
.338	.700	5.93	18
.366	.758	5.92	26
.395	.818	5.91	16
.419	.867	5.95	9
.438	.907	5.94	8
.460	.952	5.80	6
.477	.987	5.63	4

Table 8 (continued)

V 14.

Phase		m−10	n
^{d}.012	^{P}.019	5.25	7
.031	.049	5.01	5
.048	.075	4.96	6
.070	.110	5.03	7
.096	.151	5.17	15
.127	.200	5.29	11
.156	.245	5.41	14
.192	.302	5.57	15
.232	.365	5.74	11
.272	.428	5.80	14
.310	.487	5.91	7
.352	.554	5.98	12
.389	.612	6.03	8
.429	.675	6.03	12
.470	.739	5.99	16
.514	.808	6.07	9
.543	.854	6.08	13
.564	.887	6.17	6
.596	.937	6.14	6
.626	.984	5.74	6

V 15.

Phase		m−10	n
^{d}.000	^{P}.000	5.51	7
.008	.015	5.19	4
.018	.034	4.91	4
.031	.058	4.91	5
.045	.085	4.99	6
.060	.113	5.09	8
.090	.170	5.32	23
.125	.236	5.54	12
.168	.317	5.77	16
.209	.394	5.88	12
.258	.487	6.02	12
.289	.545	6.13	17
.332	.626	6.14	15
.371	.700	6.17	13
.409	.772	6.12	10
.451	.851	6.08	16
.478	.902	6.15	7
.492	.928	6.26	6
.506	.955	6.20	5
.518	.977	5.99	8

V 16.

Phase		m−10	n
^{d}.010	^{P}.020	5.17	7
.021	.041	4.93	8
.037	.072	5.00	13
.052	.102	5.12	12
.074	.145	5.32	16
.105	.205	5.54	12
.136	.266	5.73	15
.171	.334	5.84	5
.193	.377	5.92	5
.222	.434	6.00	6
.257	.502	6.10	11
.286	.559	6.20	15
.315	.616	6.24	9
.346	.676	6.23	14
.375	.733	6.22	18
.405	.792	6.21	15
.433	.847	6.26	11
.459	.897	6.29	5
.486	.950	6.23	8
.507	.991	5.64	7

V 17.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.159	^{P}.276	5.70	13
.187	.325	5.82	8
.215	.373	5.87	9
.243	.422	5.92	13
.274	.476	6.03	11
.302	.524	6.07	11
.330	.573	6.05	11
.358	.621	6.14	10
.391	.679	6.14	10
.419	.727	6.19	9
.445	.772	6.19	6
.474	.823	6.07	8
.504	.875	6.14	7
.534	.927	6.19	11
.560	.972	6.06	22

Table 8 (continued)

V 18.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.115	^{P}.223	5.58	17
.142	.275	5.68	13
.168	.325	5.78	12
.192	.372	5.96	12
.218	.422	6.10	15
.246	.476	6.10	9
.269	.521	6.31	8
.297	.575	6.30	5
.322	.624	6.34	4
.346	.670	6.26	5
.376	.728	6.24	8
.401	.777	6.24	11
.420	.813	6.28	6
.451	.873	6.25	8
.476	.922	6.30	9
.504	.976	5.98	12

V 19.

Phase		m−10	n
^{d}.015	^{P}.024	5.70	12
.048	.076	5.58	7
.078	.123	5.61	8
.110	.174	5.71	18
.142	.225	5.74	9
.169	.267	5.82	7
.200	.316	5.93	6
.238	.377	6.01	7
.269	.426	6.03	4
.305	.483	6.09	4
.333	.527	6.13	8
.361	.571	6.14	11
.391	.619	6.16	9
.427	.676	6.16	9
.465	.736	6.12	12
.492	.779	6.11	13
.520	.823	6.16	11
.554	.877	6.13	15
.583	.922	6.12	9
.618	.978	5.94	9

V 20.

Phase		m−10	n
^{d}.016	^{P}.033	5.14	13
.038	.077	4.86	5
.058	.118	4.98	6
.075	.153	5.16	7
.100	.204	5.31	15
.128	.261	5.58	16
.155	.316	5.83	13
.176	.358	5.82	8
.206	.419	5.98	8
.234	.476	6.03	9
.264	.537	6.10	8
.287	.584	6.17	7
.311	.633	6.29	6
.337	.686	6.31	5
.370	.753	6.33	8
.395	.804	6.31	13
.425	.865	6.13	6
.446	.908	6.12	8
.466	.949	6.06	9
.485	.987	5.70	8

V 21.

Phase		m−10	n
^{d}.015	^{P}.029	5.10	7
.029	.056	4.93	5
.054	.105	5.12	4
.076	.147	5.35	4
.103	.200	5.54	8
.138	.268	5.69	5
.166	.322	5.79	8
.199	.386	5.94	13
.228	.442	6.03	15
.256	.496	6.18	18
.283	.549	6.21	18
.315	.611	6.30	23
.346	.671	6.30	19
.375	.727	6.24	11
.406	.787	6.21	7
.439	.851	6.20	6
.466	.904	6.32	9
.486	.942	6.39	6
.498	.966	6.22	3
.514	.997	5.62	7

Table 8 (continued)

V 22.

Phase		m−10	n
^{d}.011	^{p}.023	5.32	12
.030	.062	5.05	13
.051	.106	4.99	16
.070	.145	5.13	8
.091	.189	5.27	9
.114	.237	5.46	17
.143	.297	5.72	13
.167	.347	5.75	7
.194	.403	5.97	12
.218	.453	5.96	.5
.252	.523	6.01	5
.263	.546	6.20	1
.300	.623	6.18	5
.331	.688	6.16	4
.357	.742	6.13	8
.379	.787	6.17	12
.410	.852	6.19	16
.432	.897	6.13	13
.452	.939	6.07	16
.471	.978	5.76	13

V 23.

Phase		m−10	n
^{d}.012	^{p}.020	5.28	11
.043	.072	5.08	11
.076	.111	5.13	10
.104	.175	5.23	11
.137	.230	5.34	15
.167	.280	5.44	14
.194	.326	5.51	12
.222	.373	5.54	13
.252	.423	5.57	6
.280	.470	5.64	10
.310	.521	5.74	9
.343	.576	5.73	11
.372	.625	5.76	10
.399	.670	5.80	8
.434	.729	5.77	8
.463	.778	5.73	12
.494	.830	5.71	7
.522	.877	5.76	10
.554	.931	5.74	13
.582	.978	5.57	12

V 24.

Phase		m−10	n
^{d}.006	^{p}.009	5.41	5
.034	.051	5.18	3
.057	.086	5.06	3
.077	.116	5.11	4
.109	.164	5.28	8
.147	.222	5.38	8
.183	.276	5.49	8
.216	.326	5.57	10
.252	.380	5.64	16
.289	.436	5.76	15
.325	.490	5.79	19
.358	.540	5.85	16
.398	.600	5.91	15
.433	.653	5.87	13
.469	.707	5.89	14
.505	.761	5.79	16
.539	.813	5.87	14
.575	.867	6.06	9
.613	.924	6.02	8
.643	.969	5.74	8

V 25.

Phase		m−10	n
^{d}.007	^{p}.015	5.05	9
.022	0.46	4.66	8
.037	.077	4.75	11
.052	.108	4.89	9
.075	.156	5.09	22
.103	.215	5.25	19
.132	.275	5.43	17
.161	.335	5.63	17
.190	.396	5.80	15
.216	.450	5.83	15
.246	.512	5.89	8
.275	.573	6.00	5
.307	.640	5.98	7
.332	.692	6.05	7
.361	.752	5.99	9
.388	.808	5.98	7
.418	.871	5.88	5
.446	.928	6.07	5
.459	.956	5.96	6
.471	.981	5.74	5

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 26.				V 27.			
^{d}.012	^{p}.020	5.18	10	^{d}.002	^{p}.003	5.54	4
.032	.054	4.91	8	.027	.047	5.19	4
.052	.087	4.95	12	.049	.085	5.08	3
.074	.124	5.07	15	.074	.128	5.26	2
.105	.176	5.21	15	.117	.202	5.44	6
.135	.226	5.35	11	.148	.256	5.60	6
.167	.279	5.49	11	.186	.321	5.70	9
.202	.338	5.59	9	.214	.370	5.81	12
.241	.403	5.63	8	.244	.421	5.87	20
.273	.457	5.76	14	.274	.473	5.92	21
.308	.515	5.83	11	.304	.525	5.96	14
.342	.572	5.86	10	.338	.584	6.02	14
.381	.637	5.86	10	.371	.640	6.04	18
.410	.686	5.89	6	.401	.692	6.06	16
.454	.760	5.93	10	.434	.749	6.02	9
.481	.805	5.92	8	.462	.798	6.02	9
.517	.865	5.97	7	.497	.858	6.04	7
.544	.910	6.04	10	.519	.896	6.07	6
.572	.957	5.91	7	.546	.943	6.08	5
.590	.987	5.59	6	.565	.976	5.89	4

Phase		m−10	n	Phase		m−10	n
V 28.				V 31.			
^{d}.011	^{p}.023	5.30	18	^{d}.009	^{p}.015	4.82	7
.032	.068	5.00	10	.029	.050	4.47	11
.059	.125	5.00	9	.058	.100	4.53	4
.080	.170	4.92	8	.086	.148	4.67	9
.102	.217	5.07	6	.114	.196	4.86	13
.126	.268	5.28	4	.142	.245	5.10	8
.152	.323	5.37	8	.176	.303	5.18	7
.178	.378	5.48	6	.213	.367	5.29	9
.195	.414	5.60	5	.244	.420	5.30	9
.221	.470	5.63	4	.271	.467	5.34	12
.247	.525	5.72	5	.305	.525	5.42	11
.268	.569	5.74	10	.342	.589	5.60	6
.296	.629	5.84	9	.371	.639	5.57	8
.320	.680	5.82	10	.400	.689	5.56	12
.342	.727	5.86	14	.433	.746	5.47	13
.368	.782	5.89	13	.467	.804	5.59	14
.389	.827	5.82	13	.493	.849	5.46	10
.412	.875	5.88	14	.522	.899	5.61	8
.433	.920	5.84	10	.549	.945	5.62	6
.458	.973	5.70	9	.572	.985	5.28	10

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 32.				**V 33.**			
^{d}.014	^{p}.028	4.66	8	—	—	—	—
.029	.059	4.62	13	—	—	—	—
.500	.101	4.78	18	—	—	—	—
.070	.141	4.93	19	—	—	—	—
.091	.184	5.03	10	—	—	—	—
.111	.224	5.24	10	^{d}.144	^{p}.267	5.49	15
.133	.268	5.31	8	.172	.327	5.53	15
.150	.303	5.39	6	.197	.375	5.61	17
.170	.343	5.47	7	.225	.428	5.73	13
.199	.402	5.42	5	.252	.480	5.73	10
.239	.482	5.67	10	.274	.522	5.81	5
.280	.565	5.61	8	.302	.575	5.72	4
.316	.638	5.65	5	.333	.634	5.81	5
.362	.731	5.66	7	.356	.678	5.84	6
.396	.799	5.51	10	.378	.720	5.86	4
.425	.858	5.54	10	.406	.773	5.84	4
.450	.908	5.64	8	.433	.824	5.82	7
.469	.947	5.68	8	.458	.872	5.89	11
.483	.975	5.45	5	.485	.923	5.86	14
.495	.999	5.02	5	.511	.973	5.64	11
V 34.				**V 35.**			
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
^{d}.154	^{p}.275	5.57	9	—	—	—	—
.184	.329	5.71	8	—	—	—	—
.210	.376	5.82	7	—	—	—	—
.240	.429	5.92	12	^{d}.224	^{p}.422	5.78	10
.264	.472	5.99	13	.250	.471	5.90	8
.296	.529	6.04	14	.280	.528	5.92	15
.322	.576	6.08	12	.303	.571	5.93	10
.347	.621	6.05	16	.332	.626	5.99	8
.376	.673	6.09	11	.360	.678	5.96	8
.408	.730	6.06	10	.385	.726	5.96	10
.435	.778	6.11	12	.413	.778	6.04	11
.461	.825	6.07	9	.439	.827	6.00	11
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Table 8 (continued)

V 36.

Phase		m−10	n
^{d}.010	^{P}.018	5.16	2
.033	.060	4.83	4
.054	.099	4.97	4
.083	.152	5.22	5
.113	.207	5.38	7
.143	.262	5.54	11
.174	.319	5.67	14
.206	.378	5.79	20
.233	.427	5.92	19
.266	.488	6.04	17
.296	.543	6.05	15
.325	.596	6.06	7
.353	.647	6.09	10
.386	.707	6.19	9
.416	.762	6.13	8
.444	.814	6.08	14
.473	.867	6.10	14
.499	.915	6.22	9
.522	.957	6.16	11
.540	.990	5.79	7

V 37.

Phase		m−10	n
^{d}.008	^{P}.024	5.59	12
.024	.073	5.50	12
.041	.126	5.44	14
.057	.175	5.41	16
.074	.227	5.43	16
.090	.276	5.43	13
.107	.328	5.51	9
.122	.374	5.55	10
.138	.422	5.64	13
.154	.471	5.72	9
.173	.530	5.80	9
.190	.582	5.86	3
.203	.621	5.93	7
.220	.674	5.99	9
.237	.726	6.02	5
.253	.775	6.02	9
.269	.824	6.02	8
.285	.873	6.00	9
.302	.925	5.93	9
.316	.967	5.84	6

V 38.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.115	^{P}.206	5.60	9
.142	.254	5.72	6
.175	.314	5.80	8
.196	.351	5.86	6
.229	.410	5.92	8
.264	.473	6.00	11
.290	.520	6.04	21
.319	.572	6.07	17
.347	.622	6.10	18
.376	.674	6.06	15
.407	.729	6.05	14
.433	.776	6.09	17
.460	.824	6.10	5
.491	.880	6.15	5
.525	.941	6.05	11
.551	.987	5.71	8

V 39.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.136	^{P}.232	5.67	15
.165	.281	5.72	16
.195	.332	5.82	10
.217	.370	5.88	6
.261	.445	6.01	4
.287	.489	6.07	8
.313	.533	6.07	11
.349	.594	6.08	6
.380	.647	6.11	4
416	.709	6.16	7
.437	.744	6.19	8
.468	.797	6.08	10
.494	.841	6.18	15
.526	.896	6.20	13
.556	.947	6.03	10
.578	.985	5.81	7

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 40.				**V 41.**			
^{d}.005	^{p}.009	5.55	7	^{d}.013	^{p}.027	5.44	6
.018	.033	5.32	5	.032	.066	5.24	4
.025	.045	5.16	5	.058	.120	5.25	6
.041	.074	5.10	9	.083	.171	5.53	2
.062	.112	5.17	4	.111	.229	5.48	6
.080	.145	5.30	6	.131	.270	5.70	4
.105	.190	5.45	11	.153	.315	5.67	4
.141	.256	5.66	7	.181	.373	5.74	5
.183	.332	5.83	6	.208	.429	5.99	6
.217	.393	5.96	13	.230	.474	5.96	8
.262	.475	6.06	16	.259	.534	6.11	10
.300	.544	6.14	15	.280	.577	6.26	17
.340	.616	6.21	20	.304	.627	6.17	18
.378	.685	6.18	21	.326	.672	6.23	19
.422	.765	6.27	10	.352	.726	6.23	16
.461	.836	6.20	19	.375	.773	6.21	16
.490	.888	6.26	10	.399	.823	6.19	19
.511	.926	6.32	13	.424	.874	6.09	11
.531	.963	6.17	8	.450	.928	5.99	7
.545	.988	5.76	5	.473	.975	5.80	7
V 42.				**V 43.**			
^{d}.004	^{p}.007	4.90	5	—	—	—	—
.014	.024	4.61	5	—	—	—	—
.030	.051	4.45	7	—	—	—	—
.049	.083	4.41	5	—	—	—	—
.071	.120	4.60	3	—	—	—	—
.107	.181	4.79	6	^{d}.149	^{p}.276	5.33	12
.136	.230	4.91	8	.174	.322	5.45	16
.191	.324	5.34	3	.203	.376	5.47	13
.231	.391	5.32	2	.228	.422	5.51	10
.256	.434	5.35	17	.256	.474	5.60	12
.299	.507	5.30	10	.283	.524	5.63	11
.344	.583	5.45	13	.310	.574	5.74	8
.380	.644	5.68	11	.337	.624	5.81	4
.420	.712	5.61	15	.367	.679	5.75	5
.463	.784	5.68	18	.395	.731	5.84	4
.500	.847	5.62	15	.418	.773	5.75	13
.526	.891	5.72	4	.446	.825	5.79	16
.549	.930	5.65	5	.473	.875	5.70	13
.569	.964	5.61	6	.497	.920	5.76	15
.588	.996	5.12	3	.526	.973	5.51	9

Table 8 (continued)

V 44.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.140	^{p}.276	5.55	14
.166	.328	5.67	15
.190	.375	5.76	10
.213	.421	5.76	9
.241	.476	5.88	6
.263	.519	5.94	7
.291	.575	5.95	7
.313	.618	5.99	8
.345	.681	6.04	13
.367	.725	6.03	9
.391	.772	6.05	16
.418	.825	6.01	14
.444	.877	6.02	8
.463	.914	6.03	8
.494	.976	5.73	9

V 45.

Phase		m−10	n
^{d}.013	^{p}.024	5.24	5
.036	.067	4.97	5
.053	.099	5.13	7
.074	.138	5.28	11
.095	.177	5.37	12
.121	.225	5.54	17
.151	.281	5.65	20
.179	.333	5.84	12
.210	.391	5.94	13
.242	.451	6.07	9
.272	.507	6.10	9
.304	.566	6.17	14
.335	.624	6.21	14
.367	.684	6.22	16
.393	.732	6.16	3
.429	.799	6.16	8
.458	.853	6.15	4
.492	.916	6.20	4
.510	.950	6.20	4
.526	.980	5.98	3

V 46.

Phase		m−10	n
^{d}.013	^{p}.021	5.55	7
.043	.070	5.44	7
.078	.127	5.32	9
.105	.171	5.39	7
.135	.220	5.56	3
.168	.274	5.65	4
.197	.321	5.67	5
.232	.378	5.70	5
.261	.426	5.74	13
.292	.476	5.79	19
.325	.546	5.84	16
.354	.577	5.81	13
.381	.621	5.87	14
.415	.677	5.92	14
.443	.722	5.95	16
.476	.776	5.91	19
.506	.825	5.88	13
.536	.874	5.92	10
.568	.926	5.90	10
.595	.970	5.77	6

V 47.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.120	^{p}.222	5.43	8
.149	.275	5.49	10
.178	.329	5.49	7
.204	.377	5.56	12
.233	.431	5.64	8
.256	.473	5.73	9
.282	.521	5.80	5
.312	.577	5.83	5
.338	.625	5.81	8
.367	.678	5.87	10
.396	.732	5.93	11
.422	.780	5.90	14
.446	.824	5.86	9
.472	.872	5.95	8
.499	.922	5.92	14
.525	.969	5.74	12

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 48.				**V 49.**			
^{d}.018	^{p}.029	5.46	7	—	—	—	—
.048	.076	5.33	6	—	—	—	—
.076	.121	5.23	5	—	—	—	—
.111	.177	5.29	10	—	—	—	—
.143	.228	5.40	13	^{d}.123	^{p}.224	5.48	12
.173	.276	5.49	17	.150	.274	5.60	9
.201	.320	5.55	11	.170	.310	5.76	2
.234	.373	5.60	9	.207	.378	5.81	6
.267	.425	5.69	15	.233	.425	5.85	9
.294	.468	5.70	15	.259	.472	5.91	8
.330	.526	5.81	11	.290	.529	5.96	9
.359	.572	5.81	11	.313	.571	5.98	11
.390	.621	5.88	14	.341	.622	5.99	11
.425	.677	5.85	10	.369	.673	6.03	13
.454	.723	5.79	8	.399	.728	6.06	15
.487	.776	5.79	8	.427	.779	5.98	17
.517	.823	5.80	12	.453	.826	6.03	14
.550	.876	5.86	9	.480	.876	6.04	12
.575	.916	5.92	5	—	—	—	—
.619	.986	5.69	9	—	—	—	—

Phase		m−10	n	Phase		m−10	n
V 50.				**V 51.**			
—	—	—	—	^{d}.014	^{p}.024	5.44	7
—	—	—	—	.035	.060	5.19	5
—	—	—	—	.052	.089	5.18	8
—	—	—	—	.071	.122	5.30	10
—	—	—	—	.095	.163	5.44	11
^{d}.140	^{p}.273	5.57	13	.126	.216	5.53	12
.166	.324	5.74	11	.155	.265	5.69	12
.193	.376	5.78	9	.191	.327	5.81	12
.220	.429	5.94	13	.223	.382	5.87	15
.242	.472	6.00	13	.257	.440	5.94	21
.268	.522	5.95	9	.292	.500	6.06	15
.296	.577	6.05	7	.327	.560	6.15	13
.321	.626	6.09	12	.357	.611	6.16	14
.345	.672	6.03	16	.389	.666	6.17	9
.369	.719	6.05	11	.423	.724	6.14	8
.397	.774	6.08	10	.466	.798	6.03	4
.421	.821	6.10	9	.494	.846	6.13	14
.450	.877	6.06	8	.523	.896	6.16	10
.474	.924	6.06	4	.552	.945	6.16	6
.500	.974	5.97	2	.574	.983	5.92	6

Table 8 (continued)

V 52.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.112	^{P}.217	5.42	10
.141	.273	5.58	11
.168	.325	5.72	9
.193	.374	5.82	10
.218	.422	5.87	14
.245	.475	5.88	17
.270	.523	5.96	13
.297	.575	6.04	14
.324	.628	6.04	17
.348	.674	6.06	9
.375	.726	5.95	1
.396	.767	6.11	3
.428	.829	6.07	5
.450	.872	6.01	8
.479	.928	6.04	13
—	—	—	—

V 53.

Phase		m−10	n
^{d}.011	^{P}.022	5.00	12
.027	.053	4.69	6
.050	.099	4.78	7
.072	.143	4.96	12
.094	.186	5.14	16
.123	.244	5.25	11
.150	.297	5.39	15
.175	.347	5.46	14
.203	.402	5.61	12
.232	.460	5.67	12
.258	.511	5.65	9
.289	.572	5.84	4
.315	.624	5.86	9
.342	.677	5.86	10
.371	735	5.79	9
.398	.788	5.75	6
.424	.840	5.80	8
.452	.895	5.85	10
.474	.939	5.90	8
.493	.976	5.63	11

V 54.

Phase		m−10	n
^{d}.013	^{P}.026	5.23	11
.039	.077	4.92	10
.062	.122	4.95	12
.086	.170	5.03	17
.115	.227	5.15	12
.139	.275	5.35	15
.164	.324	5.43	9
.191	.377	5.55	5
.217	.429	5.64	7
.240	.474	5.73	10
.265	.523	5.82	10
.286	.565	5.73	4
.315	.622	5.89	10
.340	.672	5.88	12
.364	.719	5.81	9
.390	.770	5.85	9
.418	.826	5.75	4
.439	.867	5.90	3
.469	.926	5.94	6
.496	.980	5.58	6

V 55.

Phase		m−10	n
^{d}.011	^{P}.021	5.31	11
.031	.059	4.97	13
.050	.094	5.03	9
.070	.132	5.23	13
.091	.172	5.38	13
.115	.217	5.55	16
.145	.274	5.69	16
.181	.342	5.82	11
.202	.381	5.88	9
.236	.445	6.07	10
.265	.500	6.12	8
.297	.561	6.21	8
.325	.613	6.23	6
.364	.687	6.27	5
.388	.732	6.24	10
.414	.781	6.18	10
.447	.844	6.21	12
.475	.897	6.25	11
.502	.948	6.27	9
.521	.983	5.89	9

Table 8 (continued)

V 56.

Phase		m−10	n
^{d}.009	^{P}.027	5.59	12
.025	.076	5.45	14
.043	.130	5.47	9
.060	.182	5.39	8
.076	.231	5.40	13
.090	.273	5.38	10
.107	.325	5.45	8
.125	.379	5.54	7
.141	.428	5.63	12
.159	.482	5.70	12
.174	.528	5.76	10
.189	.573	5.86	9
.208	.631	5.92	12
.224	.680	5.98	9
.238	.722	6.02	7
.256	.777	6.02	11
.273	.828	6.01	7
.290	.880	6.02	14
.307	.931	5.95	14
.322	.977	5.79	12

V 57.

Phase		m−10	n
^{d}.017	^{P}.033	5.08	3
.042	.082	4.87	5
.066	.129	5.13	10
.091	.178	5.31	9
.119	.232	5.45	12
.143	.279	5.63	15
.165	.322	5.72	14
.192	.375	5.79	16
.215	.420	5.88	14
.242	.472	6.02	12
.268	.523	6.09	8
.293	.572	6.14	12
.319	.623	6.18	17
.344	.672	6.18	9
.373	.728	6.05	11
.398	.777	6.02	9
.424	.828	6.13	5
.453	.884	6.31	1
.474	.925	6.20	5
.492	.961	5.85	1

V 58.

Phase		m−10	n
^{d}.009	^{P}.017	4.93	14
.029	.056	4.61	16
.049	.095	4.66	17
.070	.135	4.83	9
.094	.182	4.98	14
.125	.242	5.23	9
.149	.288	5.28	4
.182	.352	5.48	4
.208	.402	5.55	6
.235	.454	5.62	8
.266	.514	5.71	6
.293	.567	5.81	6
.322	.623	5.77	12
.349	.675	5.79	8
.378	.731	5.71	13
.403	.779	5.78	8
.431	.834	5.76	7
.462	.894	5.80	14
.487	.942	5.91	9
.508	.982	5.49	12

V 59.

Phase		m−10	n
^{d}.014	^{P}.024	5.45	7
.046	.078	5.26	11
.073	.124	5.37	4
.101	.172	5.48	10
.134	.228	5.59	8
.162	.275	5.69	13
.189	.321	5.81	14
.219	.372	5.89	14
.246	.418	5.91	8
.281	.477	5.98	13
.312	.530	6.02	12
.338	.574	6.09	10
.365	.620	6.06	10
.397	.674	6.12	9
.427	.725	6.18	10
.456	.774	6.14	18
.488	.829	6.20	13
.518	.880	6.18	9
.546	.927	6.16	10
.575	.977	5.86	8

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 60.				**V 61.**			
^{d}.022	^{p}.031	5.46	10	—	—	—	—
.053	.075	5.25	12	—	—	—	—
.089	.125	5.36	7	—	—	—	—
.125	.176	5.43	14	—	—	—	—
.160	.226	5.56	17	—	—	—	—
.198	.280	5.63	13	^{d}.144	^{p}.276	5.69	12
.231	.326	5.68	13	.170	.326	5.77	15
.254	.359	5.82	13	.192	.369	5.88	11
.292	.413	5.82	7	.220	.422	5.97	9
.340	.480	5.84	10	.249	.478	6.07	9
.373	.527	5.87	8	.271	.520	6.21	5
.407	.575	5.91	6	.298	.572	6.19	4
.446	.630	5.99	8	.323	.620	6.19	6
.479	.677	6.01	10	.352	.676	6.20	7
.516	.729	6.03	12	.374	.718	6.22	6
.548	.774	6.04	19	.401	.770	6.17	9
.582	.822	6.07	11	.430	.825	6.21	14
.616	.870	6.14	11	.458	.879	6.20	11
.653	.923	6.10	6	.479	.920	6.19	8
.695	.982	5.74	5	.513	.985	5.83	8
V 62.				**V 63.**			
^{d}.017	^{p}.026	5.67	16	—	—	—	—
.048	.074	5.52	13	—	—	—	—
.080	.123	5.44	15	—	—	—	—
.112	.172	5.53	12	—	—	—	—
.147	.225	5.65	6	^{d}.129	^{p}.226	5.67	5
.176	.270	5.68	4	.161	.282	5.74	5
.211	.323	5.79	6	.187	.328	5.84	6
.246	.377	5.88	8	.215	.377	5.86	5
.276	.423	5.88	11	.246	.431	5.94	6
.308	.472	5.96	14	.269	.472	6.00	12
.343	.526	6.00	10	.298	.522	6.14	9
.376	.576	6.03	17	.327	.573	6.19	10
.407	.624	6.10	12	.356	.624	6.19	11
.444	.681	6.09	9	.386	.677	6.17	12
.471	.722	6.11	8	.411	.721	6.17	12
.504	.773	6.09	8	.441	.773	6.11	7
.535	.820	6.12	6	.472	.827	6.16	15
.573	.878	6.15	8	.500	.877	6.14	13
.600	.921	6.12	11	.528	.926	6.21	13
.637	.976	5.88	15	.559	.980	5.94	11

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 64.				V 65.			
^{d}.016	^{p}.026	5.60	11	^{d}.019	^{p}.028	5.37	9
.049	.081	5.42	9	.052	.078	5.12	10
.078	.129	5.41	14	.084	.126	5.13	9
.105	.173	5.54	15	.117	.175	5.25	6
.135	.223	5.65	16	.149	.223	5.34	8
.166	.274	5.71	9	.181	.271	5.46	6
.198	.327	5.81	10	.216	.323	5.61	10
.226	.373	5.89	8	.250	.374	5.77	12
.258	.426	5.96	12	.285	.426	5.79	11
.287	.474	6.04	13	.319	.477	5.88	13
.317	.524	6.03	19	.348	.521	5.90	11
.348	.575	6.12	10	.386	.578	5.95	10
.374	.618	6.16	6	.418	.625	6.02	13
.406	.671	6.13	9	.453	.678	6.05	15
.437	.722	6.15	8	.483	.723	6.05	15
.469	.775	6.09	8	.516	.772	6.04	7
.500	.826	6.17	10	.550	.823	6.04	12
.529	.874	6.24	9	.588	.880	6.20	9
.557	.920	6.22	8	.621	.929	6.19	15
.593	.979	5.93	6	.653	.977	5.97	11
V 66.				V 67.			
^{d}.017	^{p}.027	5.29	12	—	—	—	—
.045	.073	5.22	9	—	—	—	—
.078	.126	5.31	18	—	—	—	—
.108	.174	5.41	14	—	—	—	—
.137	.221	5.51	13	^{d}.130	^{p}.229	5.47	11
.169	.273	5.64	8	.159	.280	5.60	10
.206	.332	5.70	3	.185	.325	5.69	10
.230	.371	5.72	8	.215	.378	5.75	11
.267	.431	5.80	9	.241	.424	5.84	10
.295	.476	5.78	8	.269	.473	5.90	10
.322	.519	5.92	8	.299	.526	5.91	12
.356	.574	5.92	8	.328	.577	6.00	11
.384	.619	5.91	12	.355	.625	6.04	12
.420	.677	5.95	18	.384	.676	6.06	12
.454	.732	5.90	11	.410	.721	6.05	11
.479	.772	5.85	11	.438	.771	5.94	13
.511	.824	5.86	10	.470	.827	6.03	8
.536	.864	5.91	5	.500	.880	6.17	7
.573	.924	5.88	12	.525	.924	6.08	12
.605	.976	5.71	9	.556	.978	5.82	10

Table 8 (continued)

V 69.

Phase		m−10	n
^{d}.010	^{P}.018	5.45	6
.039	.069	5.25	3
.073	.129	5.16	10
.097	.171	5.31	12
.125	.221	5.40	5
.155	.274	5.55	6
.189	.334	5.71	8
.211	.372	8.77	9
.243	.429	5.74	13
.272	.480	5.85	10
.300	.529	5.89	7
.326	.575	5.89	9
.357	.630	5.80	9
.379	.669	5.81	8
.411	.725	6.00	8
.440	.777	6.02	7
.467	.824	5.94	9
.493	.870	6.03	7
.524	.925	6.02	8
.552	.974	5.88	8

V 71.

Phase		m−10	n
^{d}.010	^{P}.018	5.30	11
.029	.053	5.08	9
.052	.095	5.16	7
.078	.142	5.22	10
.108	.197	5.40	11
.137	.250	5.51	10
.167	.304	5.64	12
.195	.355	5.72	14
.224	.408	5.78	12
.256	.466	5.88	10
.284	.517	5.72	8
.318	.579	5.89	6
.348	.634	6.13	4
.376	.685	5.98	8
.407	.741	5.97	11
.436	.794	6.03	8
.468	.852	5.95	17
.497	.905	6.03	12
.519	.945	5.93	6
.541	.985	5.63	9

V 72.

Phase		m−10	n
^{d}.009	^{P}.020	5.18	13
.030	.066	4.81	7
.048	.105	4.94	8
.068	.149	5.18	6
.094	.206	5.43	6
.121	.265	5.64	9
.143	.314	5.80	6
.168	.368	5.90	11
.191	.419	6.03	10
.217	.476	6.15	11
.242	.531	6.19	10
.270	.592	6.26	14
.293	.642	6.35	9
.317	.695	6.32	13
.341	.748	6.24	12
.365	.800	6.23	14
.385	.844	6.27	12
.405	.888	6.28	12
.425	.932	6.26	15
.446	.978	6.01	8

V 74.

Phase		m−10	n
^{d}.009	^{P}.018	5.15	12
.030	.061	4.80	15
.050	.102	4.91	10
.070	.142	5.11	10
.093	.189	5.26	13
.118	.240	5.45	7
.150	.305	5.60	8
.176	.358	5.81	7
202	410	5.97	9
.230	.467	6.04	11
.260	.528	6.10	13
.282	.573	6.17	15
.309	.628	6.19	13
.340	.691	6.16	7
.367	.746	6.23	10
.388	.788	6.18	9
.417	.847	6.06	10
.440	.894	6.18	8
.465	.945	6.09	7
.481	.977	5.88	11

Table 8 (continued)

V 75.

Phase		m−10	n
d.008	P.025	5.50	12
.025	.080	5.43	12
.040	.127	5.39	11
.054	.172	5.38	12
.069	.220	5.39	11
.087	.277	5.42	13
.102	.325	5.47	7
.118	.376	5.47	8
.133	.423	5.57	9
.149	.474	5.61	8
.165	.525	5.71	8
.179	.570	5.80	9
.196	.624	5.85	12
.212	.675	5.90	11
.229	.729	5.98	13
.245	.780	5.97	11
.260	.828	5.94	11
.274	.872	5.90	8
.289	.920	5.88	10
.306	.974	5.75	14

V 76.

Phase		m−10	n
d.002	P.004	5.45	9
.029	.058	4.91	10
.053	.106	5.08	12
.074	.147	5.25	13
.100	.199	5.48	13
.128	.255	5.62	13
.153	.305	5.86	11
.178	.355	5.93	10
.210	.419	6.19	8
—	—	—	—
.272	.542	6.28	10
—	—	—	—
.316	.630	6.28	12
—	—	—	—
.348	.694	6.10	9
.376	.749	6.17	8
.408	.813	6.15	11
—	—	—	—
.459	.915	6.46	6
—	—	—	—

V 77.

Phase		m−10	n
d.011	P.024	4.91	11
.029	.063	4.65	8
.048	.104	4.83	10
.069	.150	5.00	7
.090	.196	5.24	11
.113	.246	5.31	10
.138	.300	5.59	9
.164	.357	5.63	8
.185	.403	5.60	7
.216	.470	5.94	8
.240	.522	5.95	7
.265	.577	6.08	5
.288	.627	5.91	8
.311	.677	6.06	8
.340	.740	5.99	6
.367	.799	5.94	8
.388	.845	5.92	9
.407	.886	6.04	8
.428	.932	6.05	8
.449	.977	5.71	8

V 78.

Phase		m−10	n
d.009	P.015	5.29	11
.050	.082	4.92	7
.082	.134	5.04	6
.109	.178	5.06	7
.134	.219	5.19	12
.166	.271	5.25	11
.202	.330	5.30	10
.228	.373	5.33	14
.264	.431	5.42	8
.291	.476	5.39	15
.323	.528	5.47	14
.346	.565	5.49	9
.381	.623	5.62	7
—	—	—	—
—	—	—	—
.483	.789	5.77	4
.509	.832	5.69	5
.538	.879	5.69	6
.566	.925	5.68	13
.596	.974	5.52	14

Table 8 (continued)

V 79.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.105	^{p}.217	5.50	5
.134	.277	5.68	6
.158	.327	5.90	6
.182	.377	5.98	6
.210	.434	6.06	6
.231	.478	6.19	12
.252	.521	6.27	6
.276	.571	6.23	6
.301	.623	6.33	11
.329	.681	6.23	13
.353	.730	6.29	15
.377	.780	6.21	15
.397	.821	6.24	16
.421	.871	6.27	20
.446	.923	6.27	14
.471	.974	6.00	16

V 80.

Phase		m−10	n
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
^{d}.150	^{p}.279	5.72	8
.176	.327	5.82	6
.202	.375	5.93	7
.228	.423	5.94	7
.251	.466	6.02	6
.284	.527	6.10	7
.312	.579	6.14	7
.336	.624	6.15	11
.364	.676	6.16	19
.392	.728	6.22	13
.416	.773	6.15	15
.444	.825	6.16	14
.473	.878	6.07	14
.498	.925	6.07	12
—	—	—	—

V 81.

Phase		m−10	n
^{d}.014	^{p}.026	5.21	10
.040	.076	5.02	8
.064	.121	5.14	8
.095	.180	5.42	6
.119	.225	5.47	9
.146	.276	5.64	10
.172	.325	5.76	6
.198	.374	5.88	13
.224	.423	6.01	16
.253	.478	6.08	9
.277	.524	6.21	11
.304	.575	6.21	11
.330	.624	6.25	8
.356	.673	6.22	13
.385	.728	6.20	12
.411	.777	6.24	18
.435	.822	6.27	12
.463	.875	6.28	12
.487	.920	6.26	8
.520	.983	5.94	7

V 82.

Phase		m−10	n
^{d}.010	^{p}.019	5.29	9
.030	.057	4.96	7
.049	.093	5.03	8
.072	.137	5.22	8
.103	.196	5.44	14
.133	.254	5.60	17
.161	.307	5.71	11
.188	.358	5.80	9
.218	.416	5.96	11
.246	.469	6.08	15
.272	.519	6.17	16
.302	.576	6.25	13
.329	.627	6.29	15
.360	.686	6.33	11
.382	.728	6.25	10
.414	.789	6.22	6
.443	.845	6.19	9
.470	.896	6.22	6
.497	.948	6.29	7
.514	.980	6.07	5

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 83.				V 84.			
d.009	p.018	5.25	13	d.016	p.027	5.46	11
.031	.062	4.87	14	.043	.072	5.27	10
.049	.098	5.04	11	.072	.121	5.31	14
.073	.146	5.24	12	.103	.173	5.45	8
.103	.205	5.45	8	.135	.227	5.59	7
.128	.255	5.57	13	.162	.272	5.68	7
.155	.309	5.74	8	.199	.334	5.74	7
.178	.355	5.78	3	.225	.378	5.77	11
.211	.421	5.97	8	.253	.425	5.84	11
.236	.471	6.05	14	.282	.473	5.90	11
.265	.529	6.14	10	.315	.529	5.95	10
.290	.579	6.23	8	.340	.571	6.00	13
.320	.638	6.29	8	.376	.614	6.05	20
.351	.700	6.26	6	.402	.675	6.05	16
.369	.736	6.24	1	.429	.720	6.06	14
.405	.808	6.23	9	.461	.774	5.96	10
.427	.852	6.23	15	.489	.821	5.95	3
.450	.898	6.28	15	.518	.870	6.09	6
.469	.936	6.32	16	.554	.930	6.11	8
.488	.974	6.06	15	.582	.977	5.87	13
V 85.				V 86.			
d.009	p.025	5.51	8	d.006	p.020	5.58	9
.028	.079	5.40	10	.023	.079	5.46	10
.045	.126	5.35	8	.036	.123	5.46	10
.061	.171	5.33	13	.048	.164	5.50	12
.081	.228	5.33	10	.066	.226	5.41	13
.096	.270	5.33	11	.081	.277	5.45	11
.116	.326	5.34	13	.095	.325	5.58	15
.133	.374	5.41	17	.109	.372	5.58	9
.154	.433	5.52	9	.124	.424	5.69	14
.169	.475	5.60	11	.138	.472	5.77	11
.188	.528	5.71	12	.154	.526	5.84	12
.205	.576	5.82	7	.168	.574	5.89	11
.222	.624	5.84	12	.184	.629	6.01	11
.240	.675	5.86	10	.198	.677	6.03	14
.258	.725	5.90	10	.210	.718	6.04	10
.275	.773	5.90	9	.224	.765	6.06	6
.294	.826	5.92	7	.240	.820	6.03	7
.310	.871	5.88	7	.255	.871	6.02	7
.329	.925	5.81	9	.269	.919	5.95	10
.347	.975	5.66	13	.285	.974	5.80	5

Table 8 (continued)

V 87.

Phase		m − 10	n
^{d}.008	^{P}.022	5.32	9
.027	.076	5.19	5
.041	.115	5.14	2
.063	.176	5.17	16
.080	.224	5.13	10
.097	.271	5.14	14
.114	.319	5.23	15
.133	.372	5.34	12
.153	.428	5.36	10
.169	.473	5.41	15
.187	.523	5.53	16
.206	.576	5.61	11
.224	.627	5.59	14
.240	.671	5.58	8
.258	.722	5.62	8
.276	.772	5.66	8
.294	.822	5.67	7
.314	.878	5.67	7
.331	.926	5.63	12
.349	.976	5.49	9

V 88.

Phase		m − 10	n
^{d}.008	^{P}.027	5.32	9
.023	.077	5.15	10
.040	.134	5.08	8
.053	.178	5.09	10
.063	.211	5.11	8
.083	.278	5.14	13
.097	.325	5.13	10
.111	.372	5.15	7
.129	.432	5.24	9
.143	.479	5.27	7
.158	.529	5.38	8
.172	.576	5.42	10
.187	.626	5.50	12
.202	.677	5.55	6
.219	.734	5.60	9
.231	.774	5.62	13
.245	.821	5.64	12
.263	.881	5.66	10
.279	.935	5.67	9
.292	.978	5.50	14

V 89.

Phase		m − 10	n
^{d}.006	^{P}.011	5.30	5
.024	.044	4.99	4
.035	.064	4.85	2
.062	.113	5.00	7
.097	.177	5.18	8
.127	.232	5.33	10
.159	.290	5.53	11
.190	.346	5.53	12
.224	.408	5.72	6
.262	.478	5.81	8
.294	.536	5.79	12
.322	.587	5.84	12
.354	.645	5.88	13
.388	.707	5.85	16
.421	.768	5.85	22
.456	.831	5.87	16
.488	.890	5.94	17
.511	.932	5.91	9
.527	.961	5.90	7
.544	.992	5.58	8

V 90.

Phase		m − 10	n
^{d}.013	^{P}.025	5.18	10
.033	.064	4.92	7
.051	.099	4.98	8
.072	.139	5.19	5
.098	.190	5.36	6
.128	.248	5.61	7
.150	.290	5.73	6
.179	.346	5.84	4
.213	.412	5.89	5
.242	.468	6.02	9
.267	.516	6.10	10
.297	.574	6.14	7
.328	.634	6.21	7
.358	.692	6.17	16
.384	.743	6.17	23
.415	.803	6.14	14
.443	.857	6.17	22
.467	.903	6.23	16
.489	.946	6.24	8
.510	.986	5.88	9

Table 8 (continued)

V 91.

Phase		m−10	n
d.025	P.047	4.92	2
.051	.096	5.19	3
.077	.145	5.29	5
.104	.196	5.45	9
.132	.249	5.57	10
.157	.296	5.67	9
.181	.341	5.77	13
.209	.394	5.80	13
.235	.443	6.00	13
.265	.500	6.01	9
.289	.545	6.05	11
.313	.590	6.18	8
.341	.643	6.16	15
.369	.696	6.22	14
.395	.745	6.20	14
.423	.798	6.19	16
.447	.843	6.25	20
.475	.896	6.20	9
.499	.941	6.13	6
.529	.998	5.64	6

V 92.

Phase		m−10	n
d.015	P.030	5.16	14
.036	.071	4.98	11
.056	.111	5.02	11
.077	.153	5.22	12
.101	.201	5.39	13
.129	.256	5.58	15
.159	.316	5.70	8
.181	.359	5.80	6
.208	.413	5.91	4
.240	.477	6.04	6
.271	.538	6.11	6
.298	.592	6.14	7
.323	.641	6.19	8
.351	.697	6.21	7
.382	.759	6.30	8
.412	.818	6.30	4
.440	.874	6.22	8
.461	.915	6.30	7
.479	.951	6.18	9
.499	.991	5.71	11

V 93.

Phase		m−10	n
d.015	P.025	5.53	8
.047	0.78	5.31	6
.082	.136	5.29	4
.105	.174	5.52	8
.134	.222	5.64	5
.170	.282	5.75	5
.194	.322	5.78	12
.227	.377	5.86	11
.255	.423	5.93	8
.287	.477	5.97	9
.318	.528	6.00	8
.353	.586	6.12	9
.380	.631	6.09	10
.407	.676	6.10	20
.437	.726	6.15	26
.467	.775	6.12	17
.495	.822	6.12	14
.526	.873	6.24	8
.557	.925	6.20	7
.589	.978	5.91	8

V 94.

Phase		m−10	n
d.007	P.013	5.45	1
—	—	—	—
.065	.124	5.11	1
.097	.185	5.47	5
.125	.239	5.61	10
.153	.292	5.74	7
.177	.338	5.83	11
.201	.384	5.95	14
.225	.430	6.01	12
.253	.483	6.12	9
.281	.537	6.14	10
.306	.584	6.22	15
.336	.642	6.28	13
.359	.686	6.25	16
.386	.737	6.27	15
.412	.787	6.22	17
.440	.840	6.25	18
.464	.886	6.30	10
.492	.939	6.29	15
.511	.976	6.11	7

Table 8 (continued)

A 96.

Phase		m−10	n
^{d}.013	^{P}.026	4.98	6
.031	.062	4.75	6
.051	.102	4.85	10
.072	.144	5.08	10
.091	.182	5.17	10
.119	.238	5.35	5
.151	.302	5.58	13
.176	.352	5.67	14
.202	.404	5.82	14
.232	.465	5.86	11
.257	.515	5.97	15
.290	.581	6.04	10
.316	.633	6.09	13
.342	.685	6.10	16
.369	.739	6.07	15
.397	.795	6.03	11
.424	.849	6.00	11
.451	.903	6.06	7
.471	.943	6.00	6
.490	.981	5.80	7

V 97.

Phase		m−10	n
^{d}.006	^{P}.018	5.72	12
.026	.078	5.63	10
.043	.128	5.56	15
.059	.176	5.56	16
.077	.230	5.54	13
.091	.272	5.54	13
.110	.328	5.55	13
.125	.373	5.61	16
.140	.418	5.65	12
.158	.472	5.79	13
.178	.531	5.88	7
.194	.579	5.89	8
.210	.627	5.95	4
.226	.675	5.94	7
.243	.726	6.05	11
.259	.773	6.00	6
.277	.827	6.03	6
.293	.875	6.03	10
.308	.920	5.98	9
.325	.970	5.86	10

V 100.

Phase		m−10	n
^{d}.018	^{P}.029	5.47	9
.046	.074	5.37	16
.075	.121	5.31	12
.112	.181	5.39	7
.145	.234	5.56	4
.171	.276	5.58	7
.200	.323	5.63	8
.232	.375	5.75	6
.263	.425	5.76	7
.293	.473	5.92	3
.326	.527	5.90	4
.357	.577	5.87	14
.389	.629	5.89	17
.418	.675	5.89	17
.446	.721	5.90	17
.479	.774	5.91	9
.508	.821	5.88	7
.543	.877	5.93	4
.574	.928	5.95	13
.606	.979	5.73	16

V 101.

Phase		m−10	n
^{d}.015	^{P}.023	5.47	8
.051	.079	5.30	13
.083	.129	5.38	11
.112	.174	5.29	11
.142	.221	5.36	12
.177	.275	5.38	10
.209	.325	5.41	9
.240	.373	5.57	11
.275	.427	5.63	6
.303	.471	5.66	2
.344	.534	5.69	7
.373	.579	5.66	11
.400	.621	5.77	9
.434	.674	5.74	9
.464	.721	5.87	11
.498	.773	5.73	7
.534	.829	5.75	15
.563	.874	5.74	7
.595	.924	5.77	7
.629	.977	5.69	9

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 104.				**V 105.**			
^{d}.011	^{P}.019	4.95	6	^{d}.007	^{P}.024	5.47	9
.031	.054	4.74	5	.021	.073	5.34	14
.051	.089	4.83	9	.036	.125	5.34	8
.070	.123	4.94	13	.050	.174	5.36	11
.097	.170	5.14	15	.065	.226	5.35	11
.130	.228	5.27	10	.079	.275	5.33	7
.161	.282	5.53	4	.093	.323	5.38	10
.197	.346	5.60	6	.108	.375	5.41	13
.224	.393	5.62	9	.121	.421	5.46	9
.257	.451	5.67	12	.137	.476	5.52	15
.286	.502	5.98	4	.151	.525	5.61	11
.322	.565	5.79	7	.166	.577	5.67	7
.353	.619	6.05	6	.179	.622	5.63	7
.385	.676	5.92	7	.195	.678	5.70	9
.417	.732	6.00	6	.209	.726	5.67	10
.446	.783	5.85	4	.223	.775	5.71	8
.482	.846	5.92	4	.238	.827	5.71	9
.514	.904	5.92	3	.253	.879	5.70	10
.544	.955	5.88	5	.266	.925	5.66	13
.562	.986	5.61	6	.280	.973	5.55	14
V 106.				**V 107.**			
^{d}.011	^{P}.020	5.44	10	^{d}.007	^{P}.023	5.57	11
.038	.069	5.18	13	.023	.074	5.49	10
.063	.115	5.26	9	.038	.123	5.46	12
.096	.175	5.41	3	.055	.178	5.40	10
.124	.227	5.52	6	.072	.233	5.42	11
.149	.272	5.54	9	.087	.282	5.49	6
.181	.331	5.65	9	.101	.327	5.52	10
.208	.380	5.73	8	.116	.375	5.59	14
.236	.431	5.79	11	.130	.421	5.65	13
.261	.477	5.83	12	.147	.476	5.75	10
.287	.525	5.87	8	.161	.521	5.81	8
.316	.578	5.95	8	.176	.570	5.91	11
.345	.631	5.93	7	.194	.628	5.98	12
.369	.674	5.98	14	.210	.680	6.03	11
.398	.727	5.99	8	.226	.731	5.99	10
.424	.775	5.99	10	.241	.780	6.05	9
.449	.821	6.05	17	.254	.822	6.01	9
.476	.870	6.02	14	.268	.867	6.04	10
.504	.921	5.97	11	.287	.929	6.00	9
.532	.972	5.81	13	.301	.974	5.80	13

Table 8 (continued)

V108.

Phase		m−10	n
^{d}.006	^{p}.012	5.49	3
.031	.060	5.05	5
.049	.094	5.11	3
.072	.139	5.16	4
.090	.173	5.36	5
.115	.221	5.56	9
.147	.283	5.73	11
.177	.341	5.87	17
.206	.396	5.96	14
.236	.454	6.06	18
.265	.510	6.15	13
.294	.566	6.23	17
.326	.627	6.25	17
.354	.681	6.21	16
.384	.739	6.28	16
.413	.795	6.29	14
.445	.856	6.19	10
.466	.897	6.33	5
.490	.943	6.18	8
.507	.976	6.10	3

V. 109

Phase		m−10	n
^{d}.013	^{p}.024	4.83	5
.038	.071	4.57	6
.067	.125	4.81	8
.097	.182	4.90	10
.123	.230	5.07	10
.146	.273	5.18	10
.176	.330	5.38	8
.203	.380	5.45	6
.226	.423	5.53	6
.255	.478	5.55	10
.284	.532	5.52	8
.311	.582	5.48	6
.336	.629	5.60	11
.361	.676	5.59	12
.387	.725	5.50	13
.413	.774	5.65	13
.439	.822	5.56	13
.463	.867	5.68	10
.492	.921	5.65	7
.521	.976	5.47	3

V 110.

Phase		m−10	n
^{d}.011	^{p}.021	5.25	11
.040	.075	5.03	9
.071	.133	5.12	9
.092	.172	5.25	7
.123	.230	5.24	11
.148	.276	5.40	11
.172	.321	5.50	11
.201	.375	5.52	15
.225	.420	5.56	7
.252	.471	5.71	7
.284	.530	5.70	5
.306	.572	5.79	5
.334	.624	5.87	6
.366	.684	5.87	6
.391	.730	5.94	8
.418	.781	5.86	5
.439	.820	5.79	10
.474	.885	5.88	6
.495	.925	5.76	11
.520	.971	5.57	14

V 113.

Phase		m−10	n
^{d}.011	^{p}.021	5.02	5
.033	.064	4.95	9
.049	.096	5.04	15
.071	.138	5.19	15
.094	.183	5.42	20
.124	.242	5.60	23
.150	.292	5.74	17
.179	.349	5.86	10
.207	.404	6.00	16
.238	.464	6.14	14
.267	.520	6.21	10
.290	.565	6.22	5
.336	.655	6.18	2
.351	.688	6.19	6
.380	.741	6.23	5
.412	.803	6.22	4
.438	.854	6.18	9
.462	.901	6.24	7
.483	.942	6.23	7
.502	.979	5.99	4

Table 8 (continued)

V 114.

Phase		m−10	n
d.013	p.022	5.59	7
.048	.080	5.19	4
.074	.124	5.36	5
.103	.172	5.50	8
.133	.223	5.66	7
.166	.278	5.76	9
.195	.326	5.80	10
.223	.373	5.91	11
.257	.430	5.98	15
.286	.478	6.06	16
.312	.522	6.05	13
.345	.577	6.07	12
.378	.632	6.09	12
.405	.678	6.09	16
.437	.731	6.12	11
.464	.776	6.14	12
.493	.825	6.11	9
.521	.872	6.19	9
.550	.920	6.22	9
.584	.977	5.90	12

V 115.

Phase		m−10	n
d.007	p.014	5.31	10
.028	.055	4.98	6
.051	.099	5.09	7
.069	.134	5.27	8
.091	.177	5.45	13
.121	.236	5.63	9
.156	.304	5.79	8
.181	.353	5.88	9
.211	.411	6.07	11
.240	.468	6.12	16
.267	.520	6.17	9
.294	.573	6.26	10
.325	.633	6.27	13
.354	.690	6.26	9
.381	.742	6.24	15
.410	.799	6.30	12
.441	.859	6.29	13
.467	.910	6.33	5
.484	.943	6.33	8
.503	.980	6.04	11

V 116.

Phase		m−10	n
d.010	p.019	5.24	7
.028	.054	4.90	7
.048	.093	5.07	6
.074	.144	5.25	11
.101	.196	5.48	14
.132	.256	5.68	9
.156	.303	5.81	15
.187	.363	5.90	13
.216	.420	6.08	17
.244	.474	6.16	13
.268	.521	6.26	5
.297	.577	6.31	8
.330	.641	6.36	8
.358	.695	6.40	10
.384	.746	6.24	11
.412	.800	6.24	15
.441	.857	6.29	15
.467	.907	6.28	9
.485	.942	6.31	5
.504	.979	5.97	10

V 117.

Phase		m−10	n
d.016	p.027	5.32	10
.045	.075	5.26	14
.076	.127	5.43	9
.106	.177	5.52	8
.134	.223	5.65	9
.167	.278	5.70	14
.192	.320	5.76	6
.226	.376	5.88	6
.256	.426	5.94	10
.289	.481	5.96	6
.321	.535	6.08	3
.344	.573	6.15	10
.374	.623	6.09	11
.407	.678	6.13	18
.436	.726	6.10	18
.464	.773	6.12	16
.491	.818	6.19	6
.524	.873	6.20	11
.557	.928	6.08	8
.589	.981	5.81	8

Table 8 (continued)

V 118.

Phase		m−10	n
d.010	p.020	5.24	15
.031	.062	4.92	14
.048	.096	5.01	12
.074	.148	5.25	9
.102	.204	5.45	10
.128	.256	5.63	7
.156	.312	5.85	7
.178	.356	5.98	5
.206	.413	5.94	4
.233	.467	6.07	6
.261	.523	6.22	5
.291	.583	6.31	12
.319	.639	6.26	9
.349	.699	6.32	11
.373	.747	6.24	17
.398	.797	6.20	13
.425	.851	6.19	12
.448	.897	6.28	12
.469	.939	6.34	14
.489	.979	5.94	12

V 119.

Phase		m−10	n
d.011	p.021	5.25	10
.032	.062	4.89	9
.054	.104	4.94	11
.072	.139	5.09	10
.095	.183	5.25	13
.126	.243	5.54	9
.153	.296	5.57	15
.185	.357	5.79	7
.213	.411	5.87	12
.242	.467	5.96	10
.270	.521	6.19	11
.301	.581	6.13	13
.331	.639	6.13	13
.357	.690	6.23	12
.388	.749	6.17	14
.419	.809	6.11	9
.447	.863	6.22	6
.477	.921	6.15	6
.493	.952	6.10	7
.510	.985	5.67	6

V 120.

Phase		m−10	n
d.018	p.028	5.70	11
.048	.075	5.60	9
.082	.128	5.56	12
.114	.178	5.59	12
.146	.228	5.70	11
.176	.275	5.69	12
.210	.328	5.83	8
.241	.376	5.81	9
.271	.423	5.88	9
.302	.472	5.92	9
.338	.528	5.92	5
.366	.572	5.93	6
.398	.622	5.97	10
.432	.675	6.01	15
.464	.725	6.04	14
.496	.775	6.07	15
.529	.826	6.05	17
.561	.876	6.06	13
.593	.926	5.99	9
.623	.973	5.91	3

V 121.

Phase		m−10	n
d.015	p.028	4.84	13
.043	.080	4.87	12
.067	.125	4.96	8
.093	.174	4.92	12
.121	.226	4.97	9
.149	.278	5.07	10
.175	.327	5.24	10
.201	.376	5.25	8
.227	.424	5.25	6
.256	.478	5.32	5
.283	.529	5.54	7
.308	.575	5.60	6
.332	.620	5.56	7
.364	.680	5.51	3
.396	.740	5.60	4
.418	.781	5.50	10
.441	.824	5.45	13
.470	.878	5.46	15
.495	.925	5.35	17
.525	.981	5.12	16

Table 8 (continued)

V 123.

Phase		m−10	n
^{d}.009	^{P}.017	5.37	6
.032	.059	4.93	6
.059	.108	5.21	6
.086	.158	5.44	11
.115	.211	5.61	10
.141	.259	5.79	11
.173	.317	5.91	19
.204	.374	5.98	13
.230	.422	6.09	9
.260	.477	6.17	7
.294	.539	6.22	3
.319	.585	6.28	5
.350	.642	6.25	10
.384	.704	6.23	10
.412	.755	6.24	11
.436	.799	6.32	9
.472	.865	6.29	11
.494	.906	6.22	4
.516	.946	6.28	7
.535	.981	5.94	5

V 124.

Phase		m−10	n
^{d}.016	^{P}.021	5.65	7
.054	.072	5.60	10
.095	.126	5.54	7
.132	.175	5.50	13
.170	.226	5.52	15
.208	.276	5.62	13
.245	.326	5.65	15
.279	.371	5.71	9
.320	.425	5.72	10
.360	.478	5.79	7
.395	.525	5.76	4
.433	.575	5.83	8
.470	.625	5.88	11
.508	.675	5.89	19
.541	.719	5.87	16
.578	.768	5.93	3
.621	.825	5.86	8
.655	.871	5.96	9
.695	.924	5.87	12
.732	.973	5.76	10

V 125.

Phase		m−10	n
^{d}.010	^{P}.029	5.63	12
.026	.074	5.59	12
.043	.123	5.50	12
.063	.180	5.50	13
.080	.229	5.50	8
.098	.280	5.47	7
.115	.329	5.52	10
.132	.377	5.56	9
.150	.429	5.71	8
.167	.477	5.77	9
.185	.529	5.79	13
.203	.580	5.81	7
.219	.626	5.90	8
.237	.677	5.93	11
.256	.732	5.99	8
.272	.778	6.00	13
.290	.829	5.94	9
.310	.886	5.94	11
.324	.926	5.90	13
.342	.978	5.75	14

V 126.

Phase		m−10	n
^{d}.009	^{P}.026	5.55	13
.027	.077	5.53	15
.043	.123	5.49	7
.061	.175	5.40	8
.078	.224	5.44	11
.096	.276	5.46	14
.113	.324	5.49	9
.130	.373	5.55	13
.151	.433	5.61	8
.165	.474	5.67	9
.183	.525	5.77	6
.202	.583	5.72	8
.217	.623	5.86	9
.236	.677	5.86	9
.253	.726	5.87	12
.269	.772	5.87	15
.287	.824	5.97	9
.305	.875	5.89	6
.324	.930	5.86	8
.340	.976	5.69	11

Table 8 (continued)

Phase		m−10	n	Phase		m−10	n
V 131.				**V 140.**			
d.007	P.024	5.30	9	d.010	P.030	5.22	10
.021	.071	5.16	10	.025	.075	5.13	10
.036	.121	5.10	9	.042	.126	5.10	12
.052	.175	5.13	7	.058	.174	5.09	13
.067	.225	5.04	7	.074	.222	5.07	14
.080	.269	5.06	7	.093	.279	5.15	14
.095	.319	5.08	7	.108	.324	5.22	9
.109	.366	5.20	5	.125	.375	5.22	14
.125	.420	5.22	8	.142	.426	5.32	7
.142	.477	5.31	10	.157	.471	5.37	12
.157	.527	5.38	6	.175	.525	5.38	12
.171	.574	5.36	11	.191	.573	5.49	9
.185	.621	5.42	4	.208	.624	5.49	6
.202	.679	5.49	8	.224	.672	5.48	8
.219	.736	5.52	8	.238	.714	5.52	4
.231	.776	5.48	6	.258	.774	5.44	3
.249	.836	5.56	12	.276	.829	5.51	7
.263	.883	5.51	7	.290	.871	5.50	12
.277	.930	5.47	9	.308	.925	5.51	9
.291	.978	5.39	14	.326	.979	5.39	10
V 142.							
d.013	P.023	5.04	9				
.039	.069	4.78	11				
.073	.128	4.98	11				
.100	.176	5.07	17				
.127	.223	5.20	13				
.155	.273	5.31	8				
.186	.327	5.40	10				
.218	.383	5.38	10				
.242	.426	5.53	14				
.272	.478	5.56	8				
.300	.528	5.50	8				
.325	.572	5.60	6				
.359	.631	5.69	5				
.385	.677	5.47	6				
.416	.732	5.68	4				
.441	.776	5.71	7				
.472	.830	5.59	6				
.500	.879	5.73	7				
.524	.922	5.64	7				
.558	.981	5.31	8				

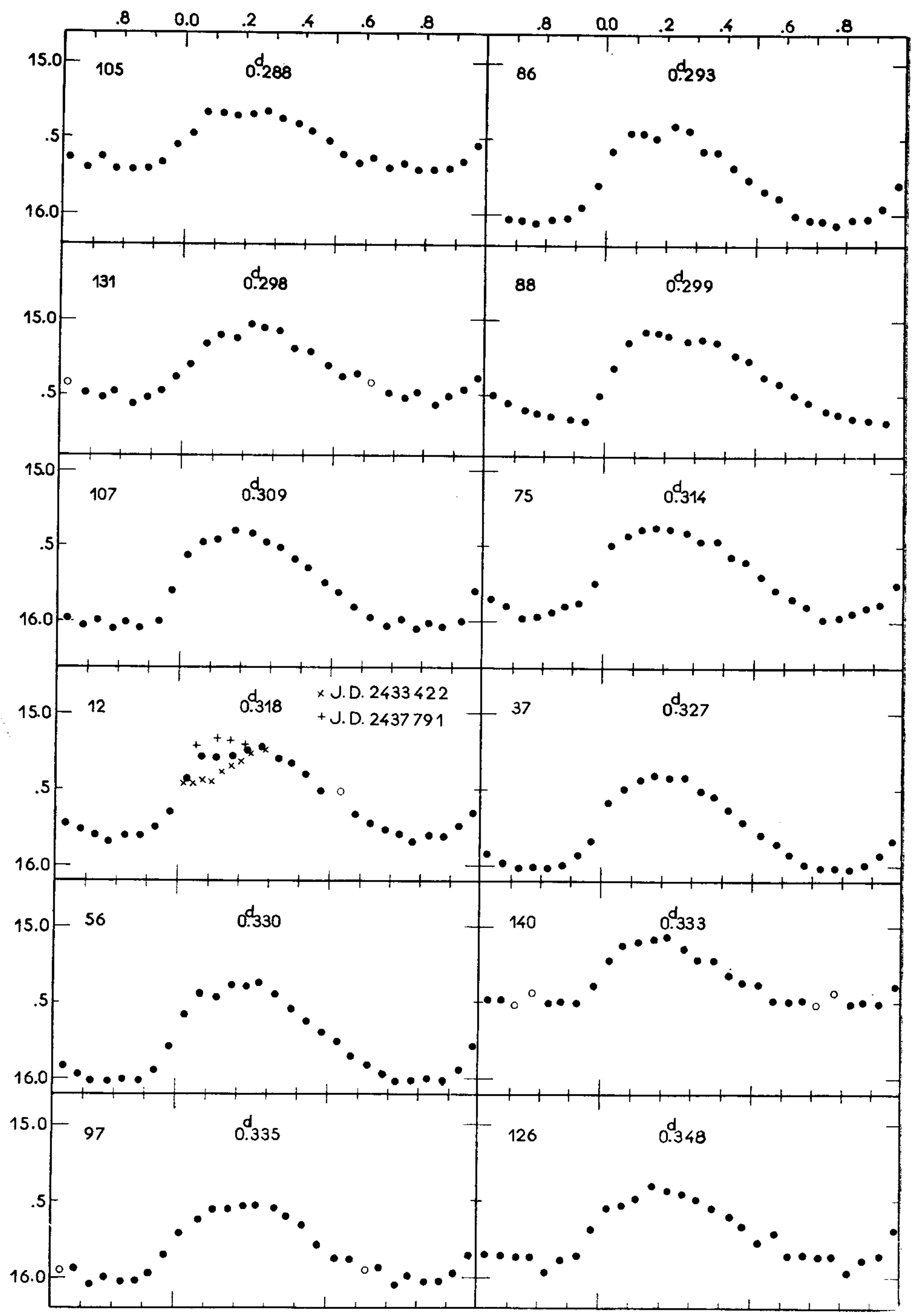


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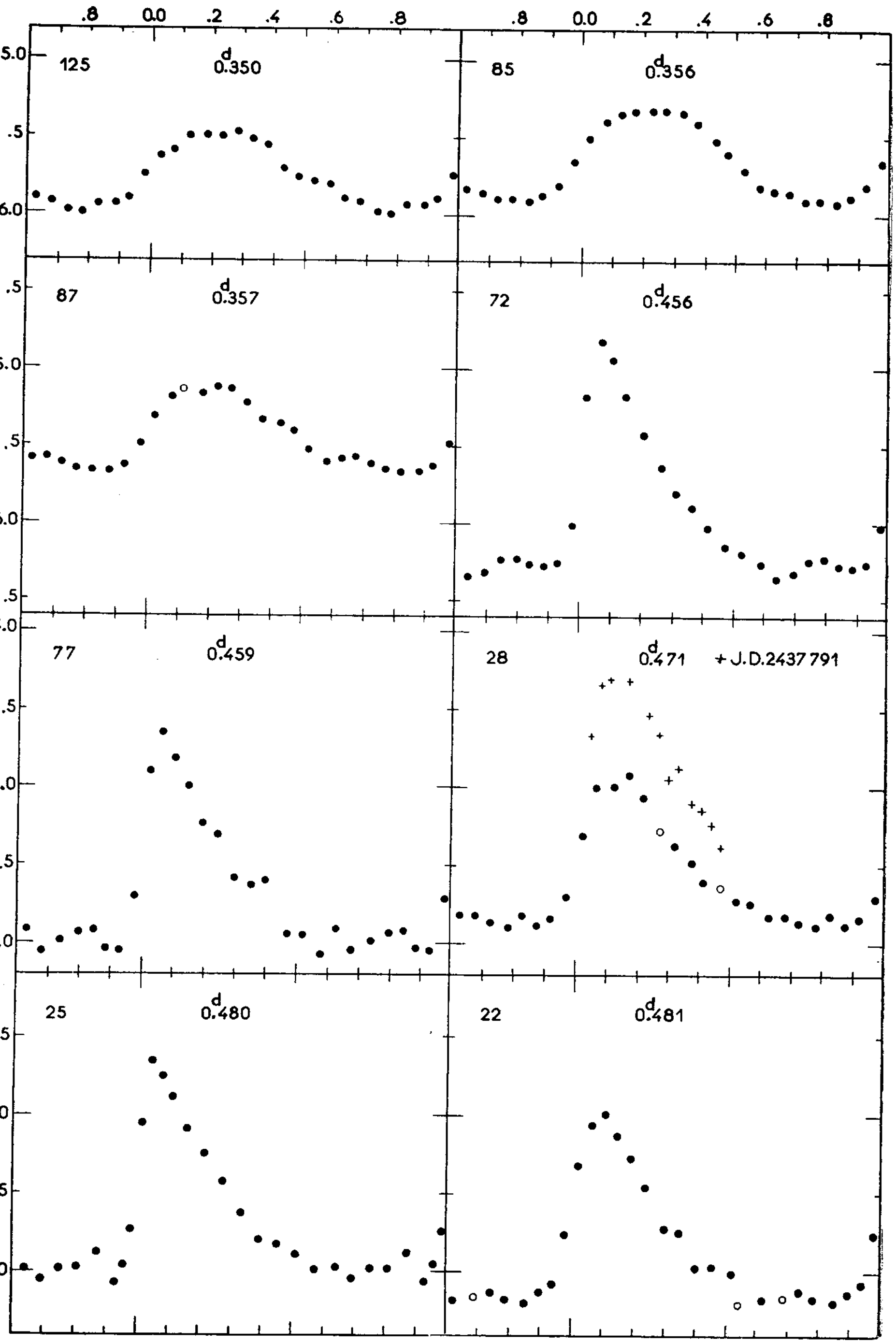
Figure 15.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$0^d.481$

Figure 16.

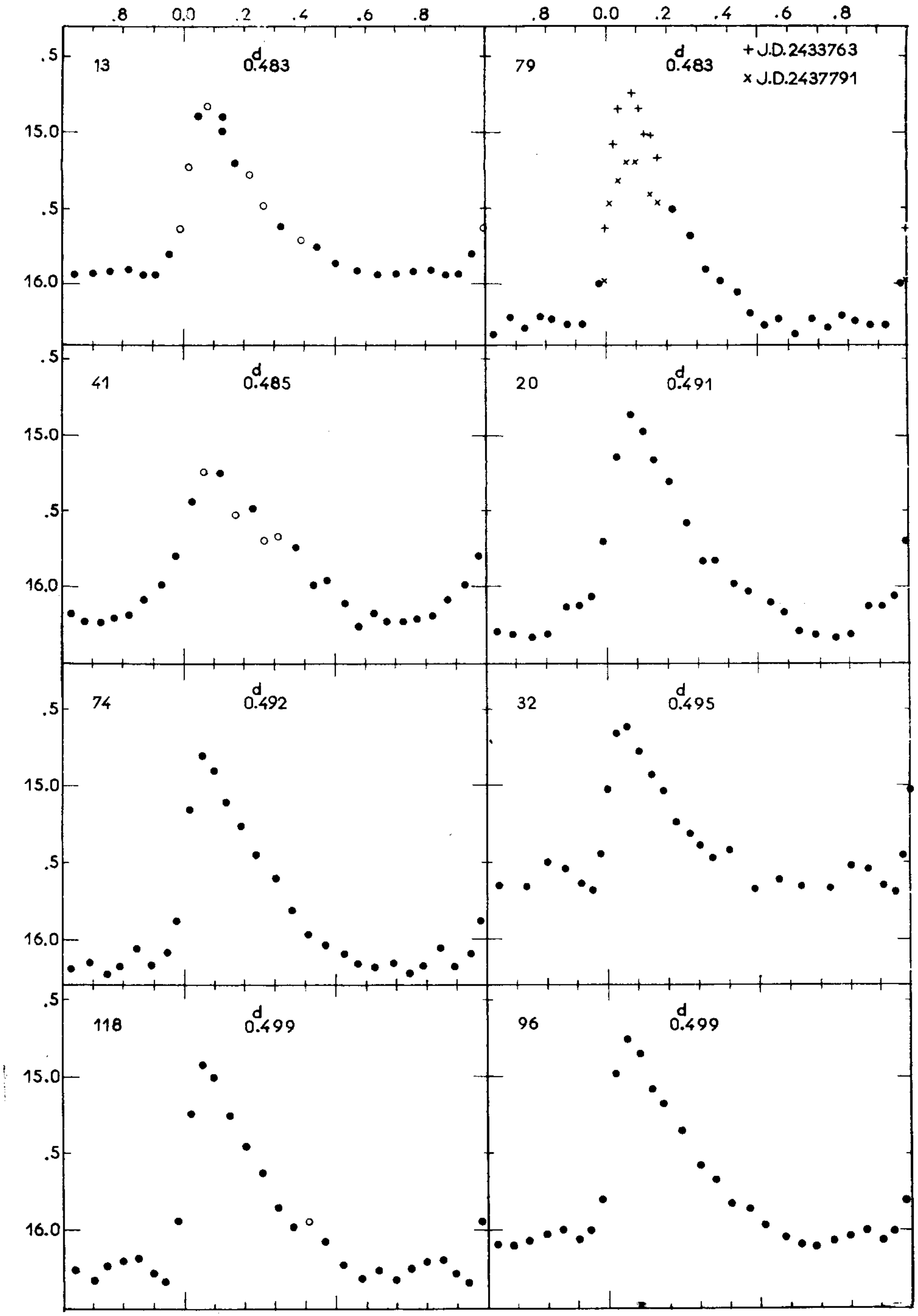

13
0.483 d
79
0.483 d
+ J.D.2433763
× J.D.2437791
41
0.485 d
20
0.491 d
74
0.492 d
32
0.495 d
118
0.499 d
96
0.499 d

Figure 17.

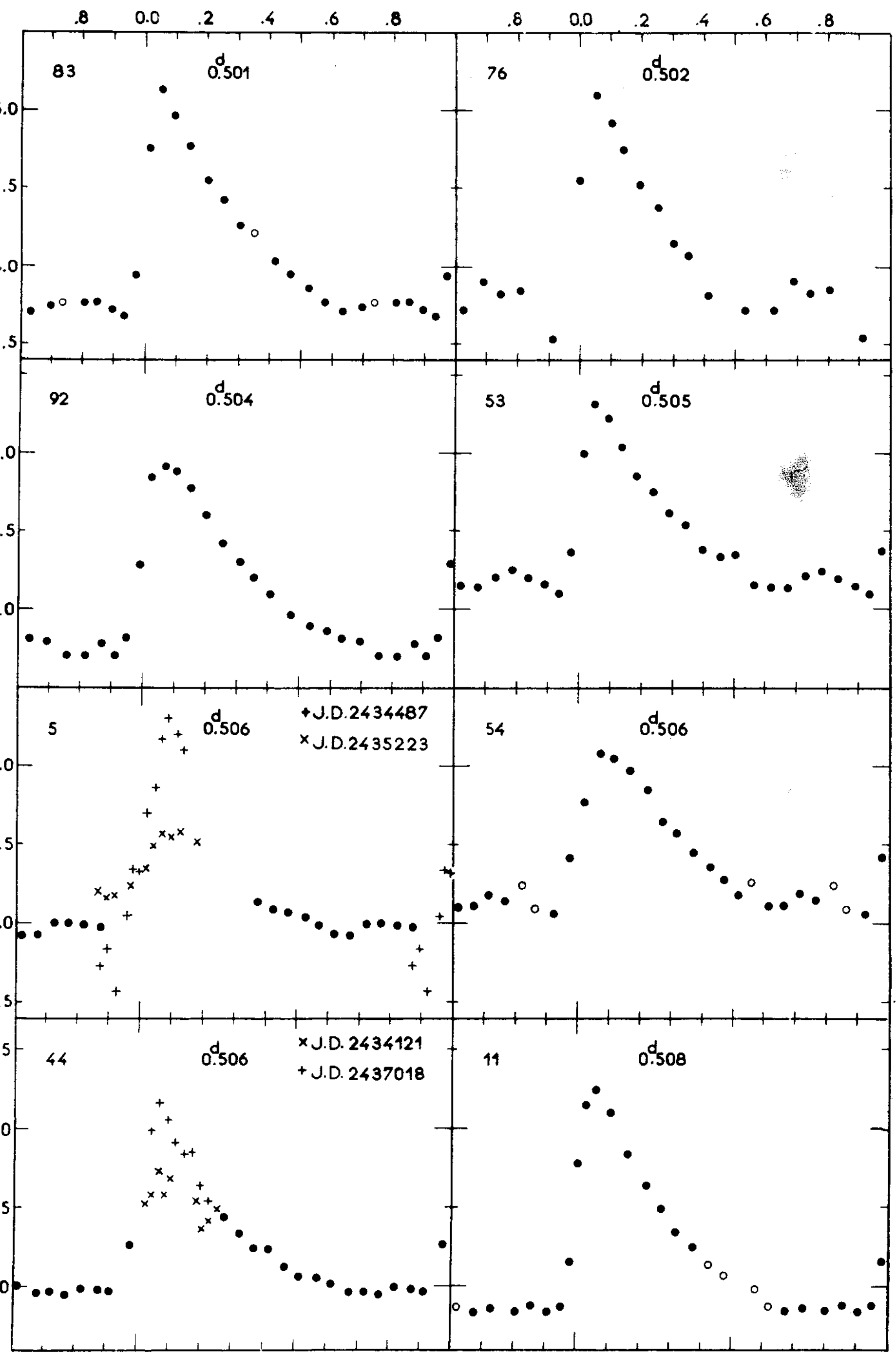

83
0.501
76
0.502
92
0.504
53
0.505
5
0.506
+J.D.2434487
×J.D.2435223
54
0.506
44
0.506
×J.D.2434121
+J.D.2437018
11
0.508

Figure 18.

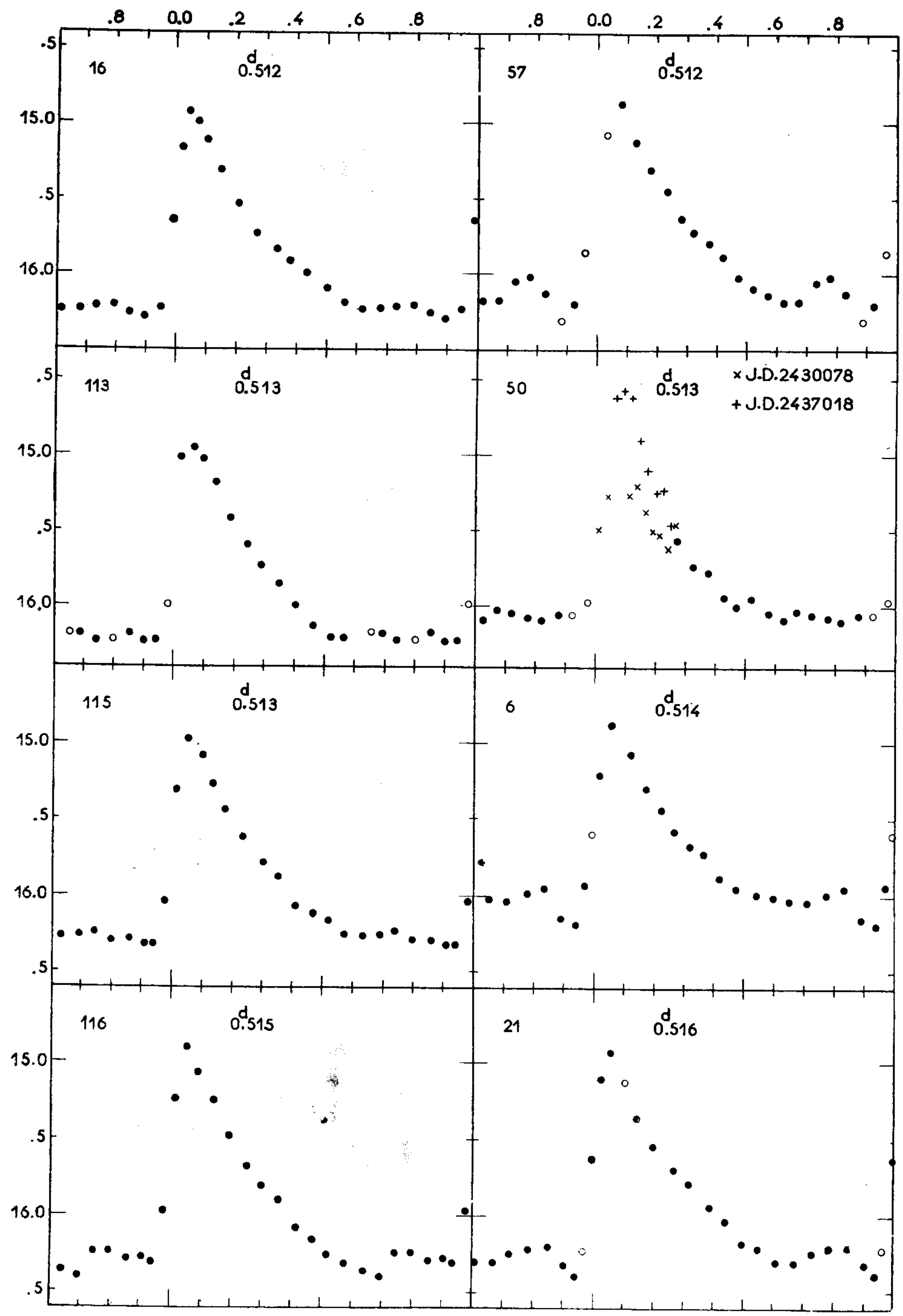

.8
0.0
.2
.4
.6
.8
16
$0^{d}.512$
57
$0^{d}.512$
113
$0^{d}.513$
50
$0^{d}.513$
× J.D.2430078
+ J.D.2437018
115
$0^{d}.513$
6
$0^{d}.514$
116
$0^{d}.515$
21
$0^{d}.516$
.5
15.0
.5
16.0

Figure 19.

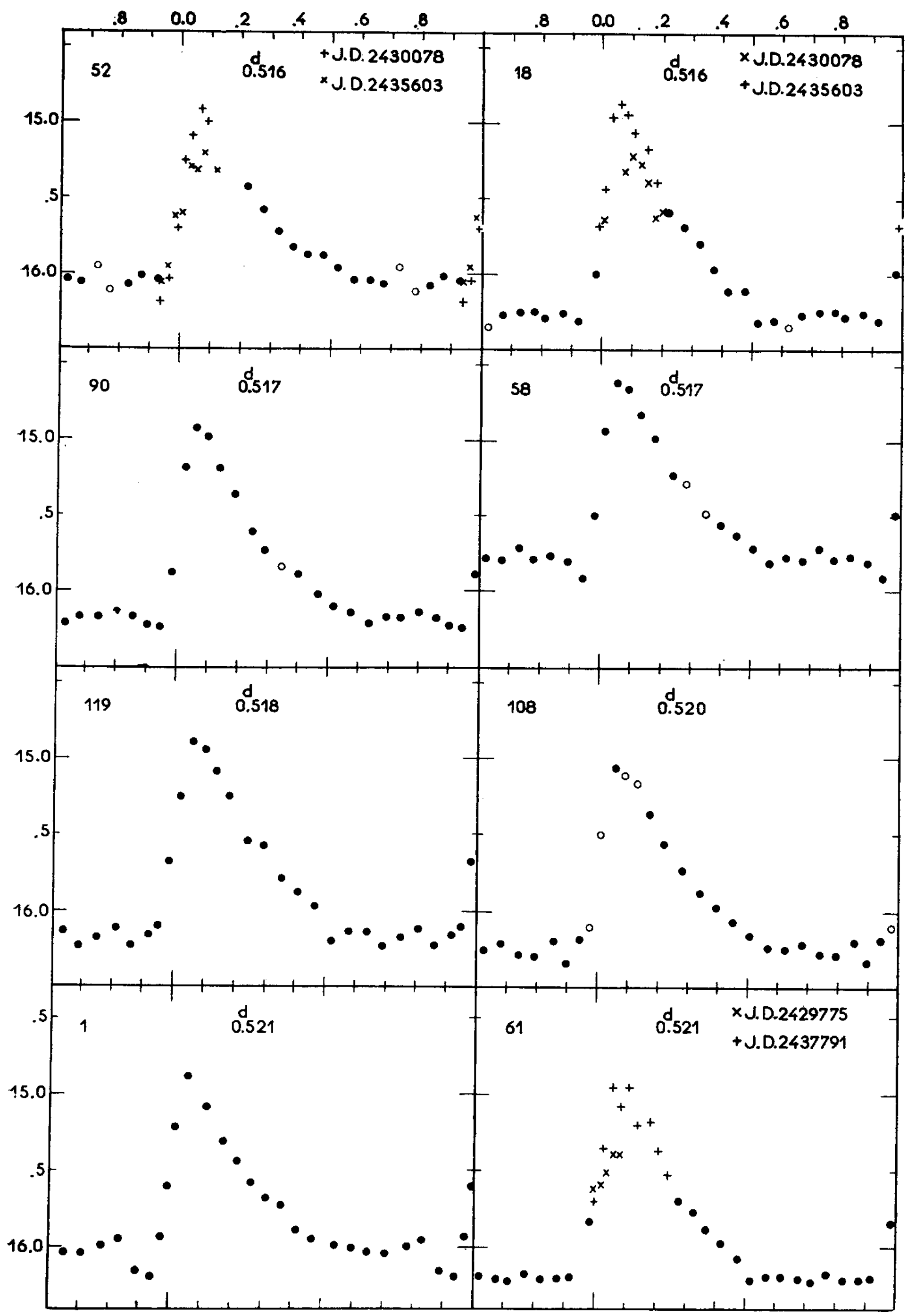
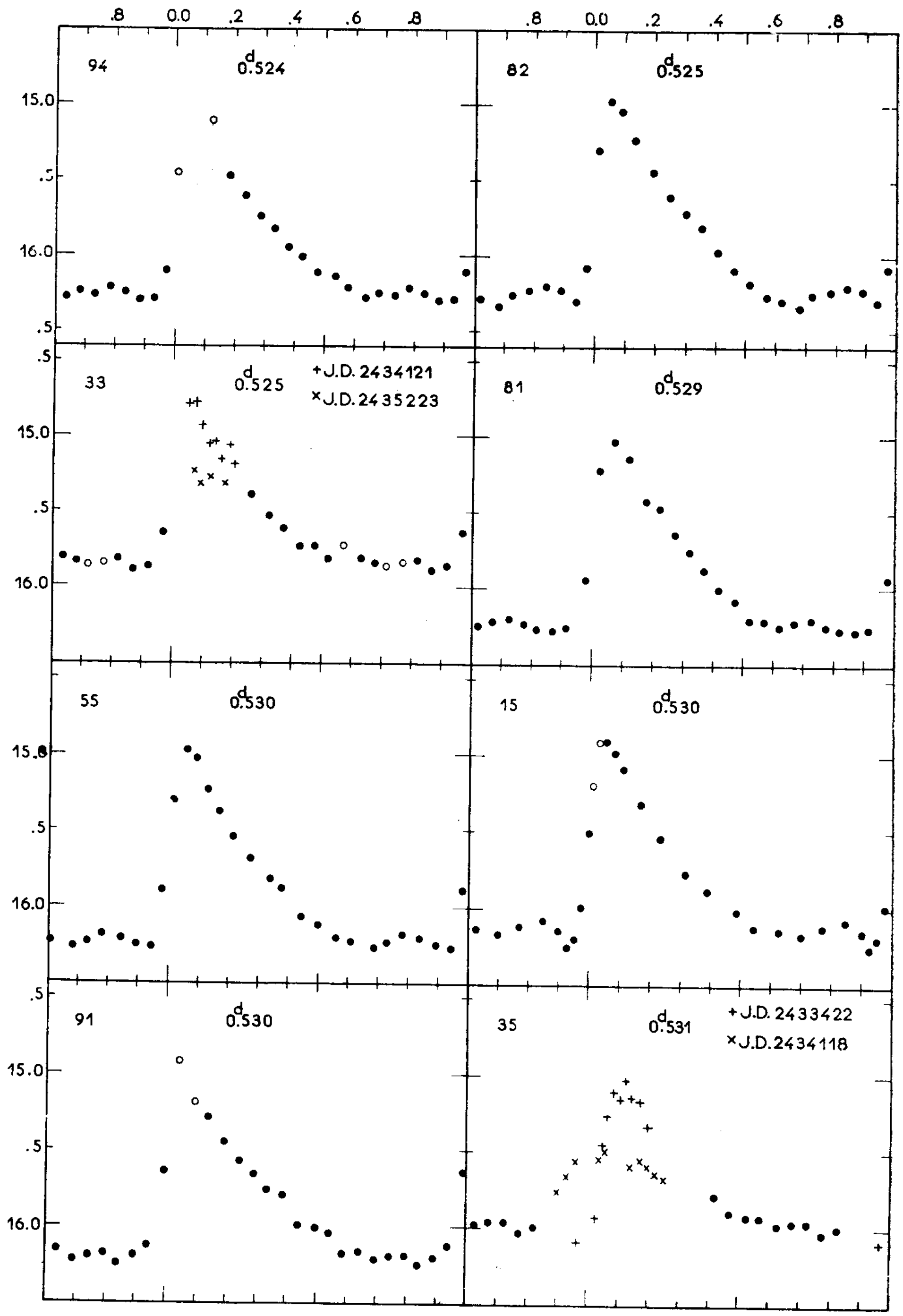
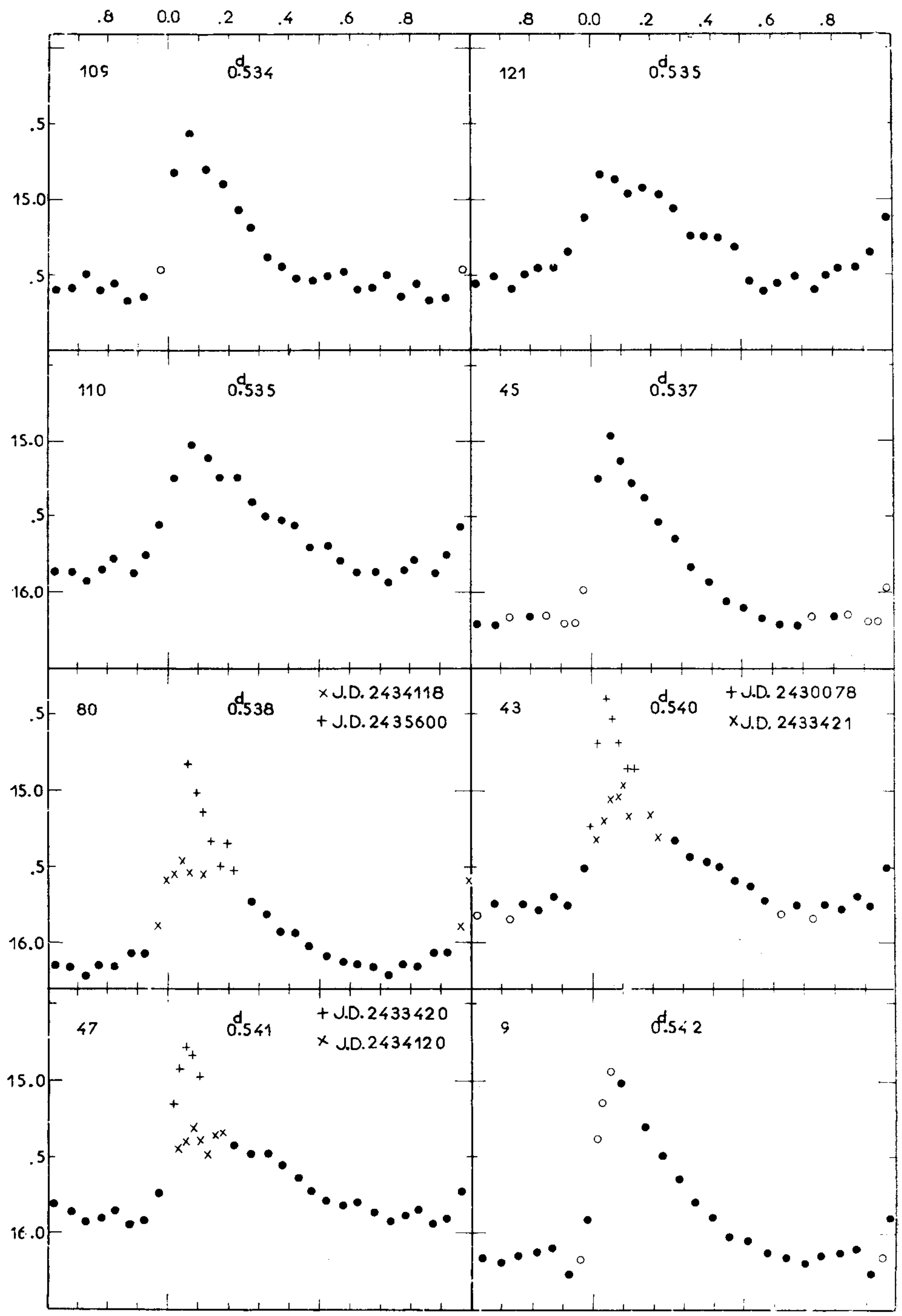

.8
0.0
.2
.4
.6
.8
52
$0^d.516$
+ J.D. 2430078
× J.D. 2435603
18
$0^d.516$
× J.D.2430078
+ J.D.2435603
15.0
.5
16.0
90
$0^d.517$
58
$0^d.517$
119
$0^d.518$
108
$0^d.520$
1
$0^d.521$
61
$0^d.521$
× J.D.2429775
+ J.D.2437791

Figure 20.



.8
0.0
.2
.4
.6
.8
94
0.d524
82
0.d525
15.0
.5
16.0
33
0.d525
+J.D. 2434121
×J.D. 2435223
81
0.d529
55
0.d530
15
0.d530
91
0.d530
35
0.d531
+J.D. 2433422
×J.D. 2434118

Figure 21.



.8 0.0 .2 .4 .6 .8
109 0.d534
121 0.d535
110 0.d535
45 0.d537
80 0.d538
× J.D. 2434118
+ J.D. 2435600
43 0.d540
+ J.D. 2430078
× J.D. 2433421
47 0.d541
+ J.D. 2433420
× J.D. 2434120
9 0.d542
15.0
.5
16.0

Figure 22.

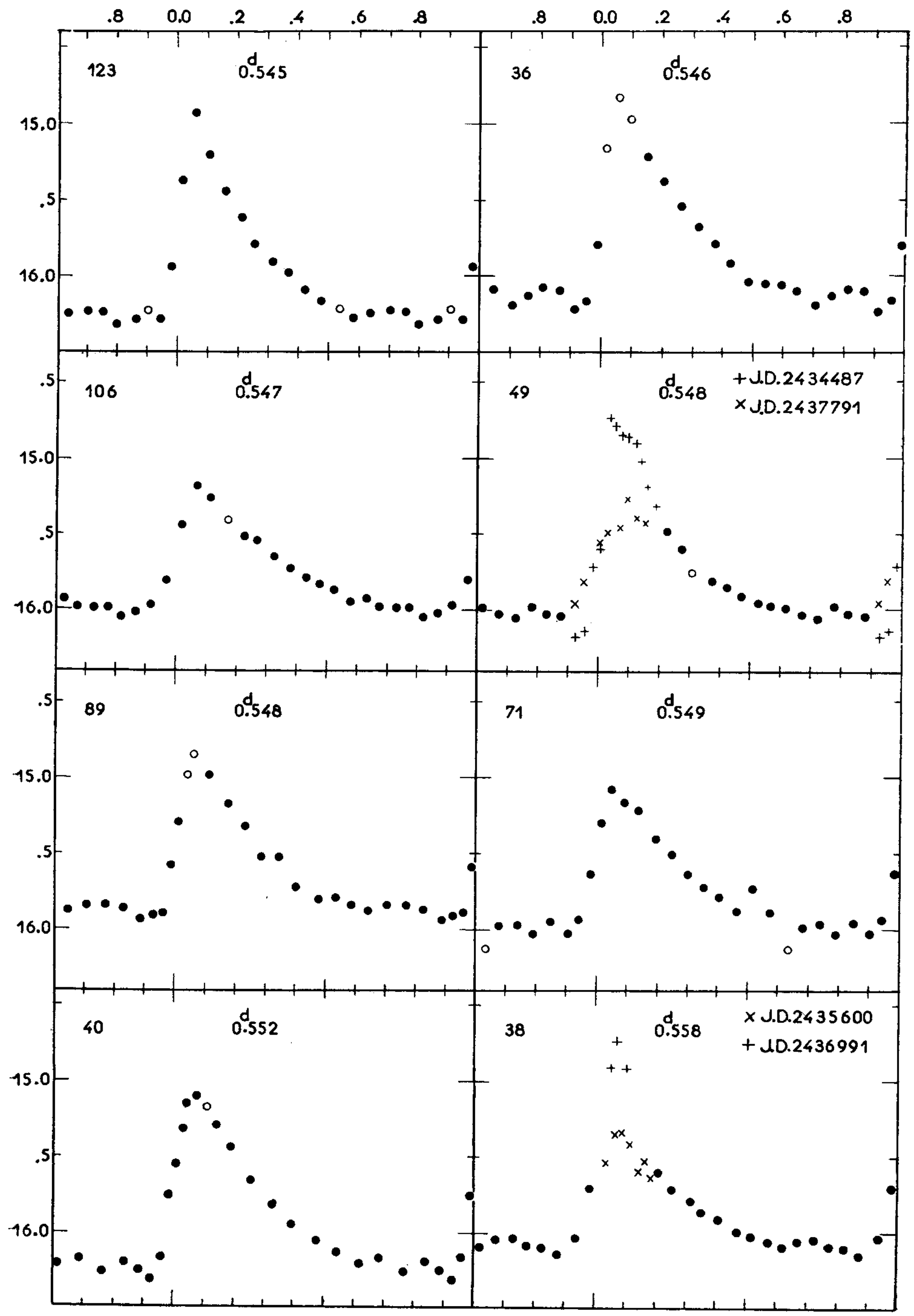

.8
0.0
.2
.4
.6
.8
123
0.545
36
0.546
106
0.547
49
0.548
+J.D.2434487
×J.D.2437791
89
0.548
71
0.549
40
0.552
38
0.558
×J.D.2435600
+J.D.2436991
15.0
.5
16.0

Figure 23.

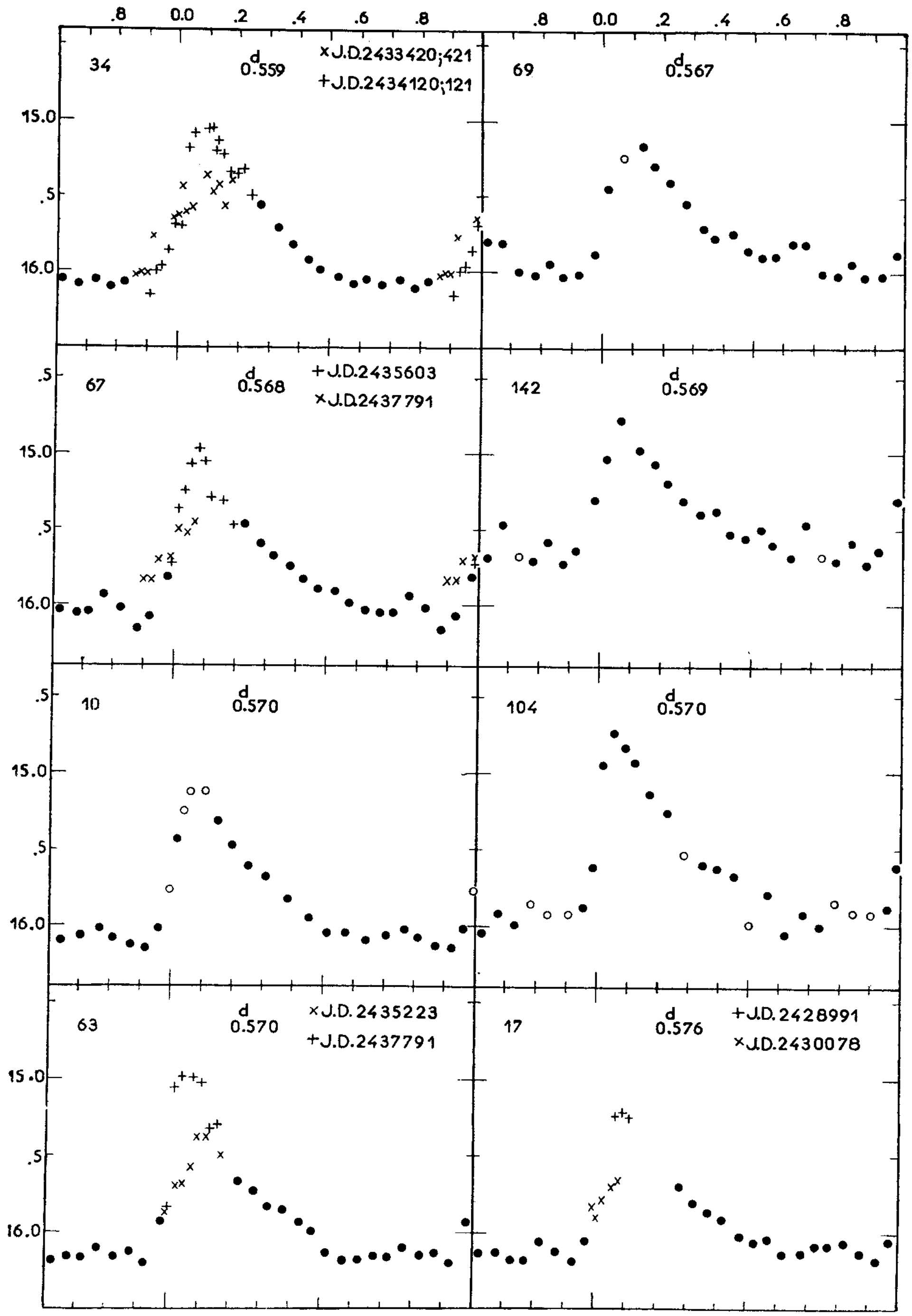

.8
0.0
.2
.4
.6
.8
34
0.559 d
×J.D.2433420;421
+J.D.2434120;121
69
0.567 d
15.0
.5
16.0
67
0.568 d
+J.D.2435603
×J.D.2437791
142
0.569 d
10
0.570 d
104
0.570 d
63
0.570 d
×J.D.2435223
+J.D.2437791
17
0.576 d
+J.D.2428991
×J.D.2430078

Figure 24.

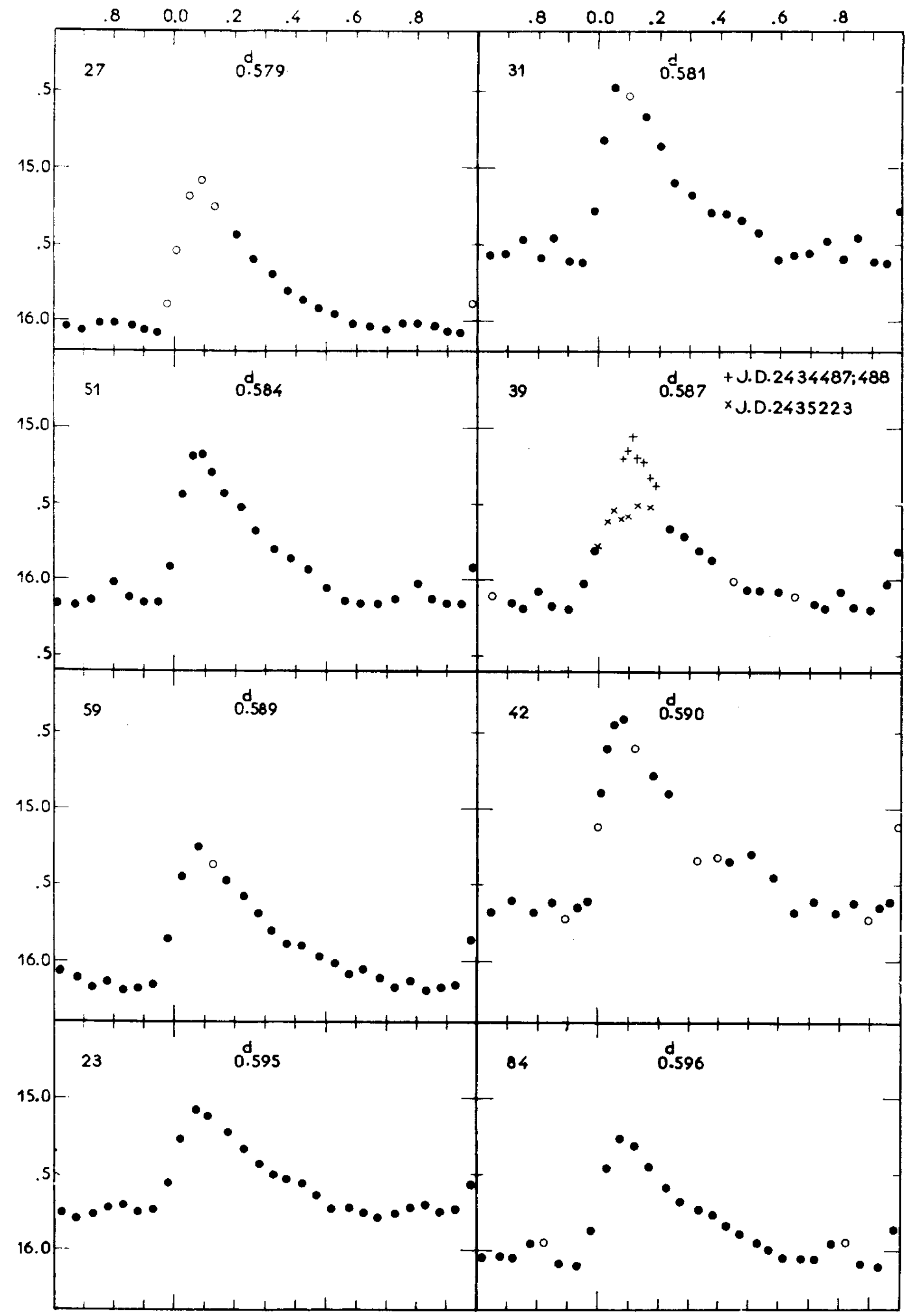
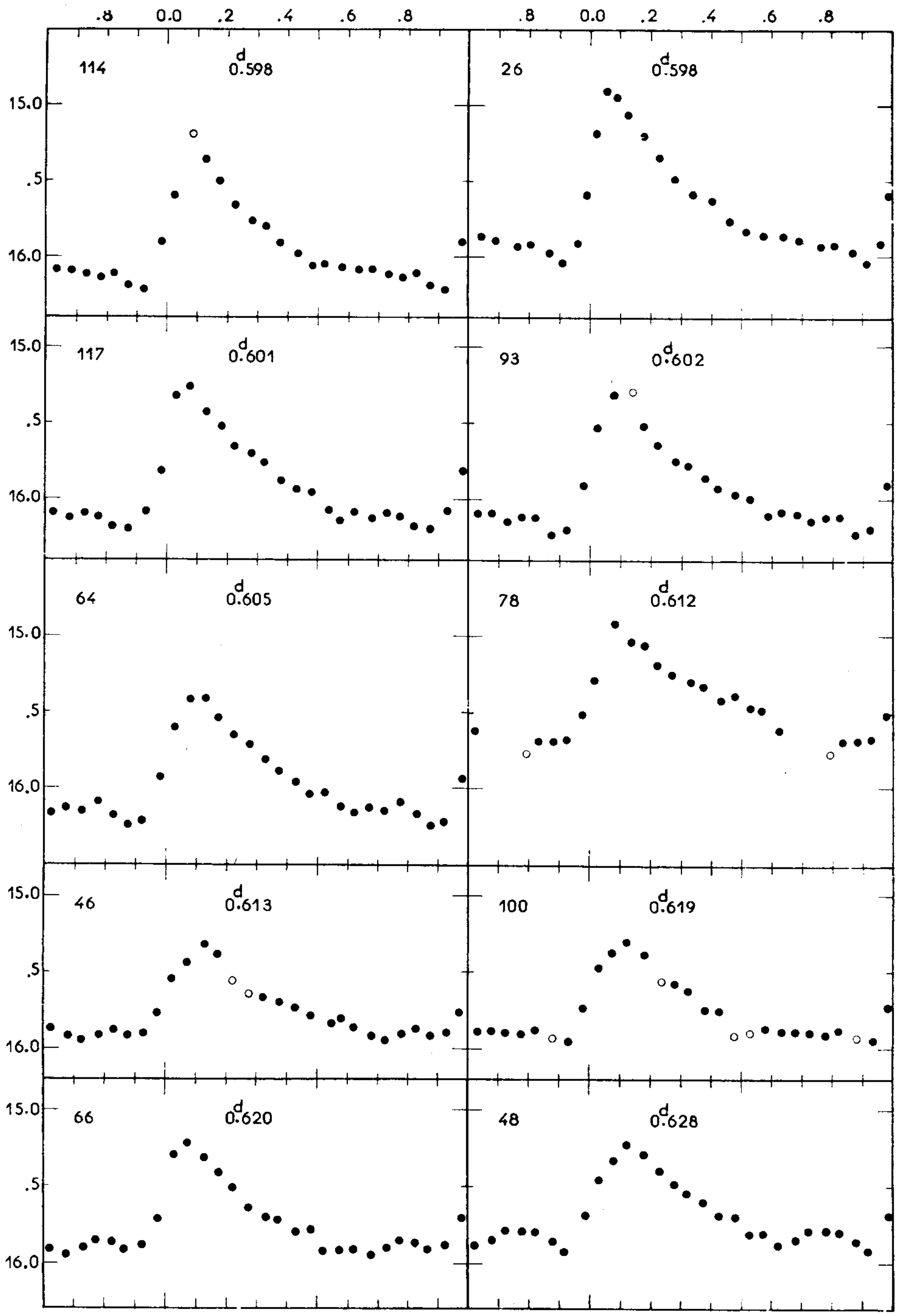

.8 0.0 .2 .4 .6 .8
27 0.579
31 0.581
51 0.584
39 0.587
+J.D.2434487;488
×J.D.2435223
59 0.589
42 0.590
23 0.595
84 0.596
15.0
16.0
.5

Figure 25.



.8 0.0 .2 .4 .6 .8
.8 0.0 .2 .4 .6 .8
114 0.598d
26 0.598d
117 0.601d
93 0.602d
64 0.605d
78 0.612d
46 0.613d
100 0.619d
66 0.620d
48 0.628d
15.0
.5
16.0

Figure 26.

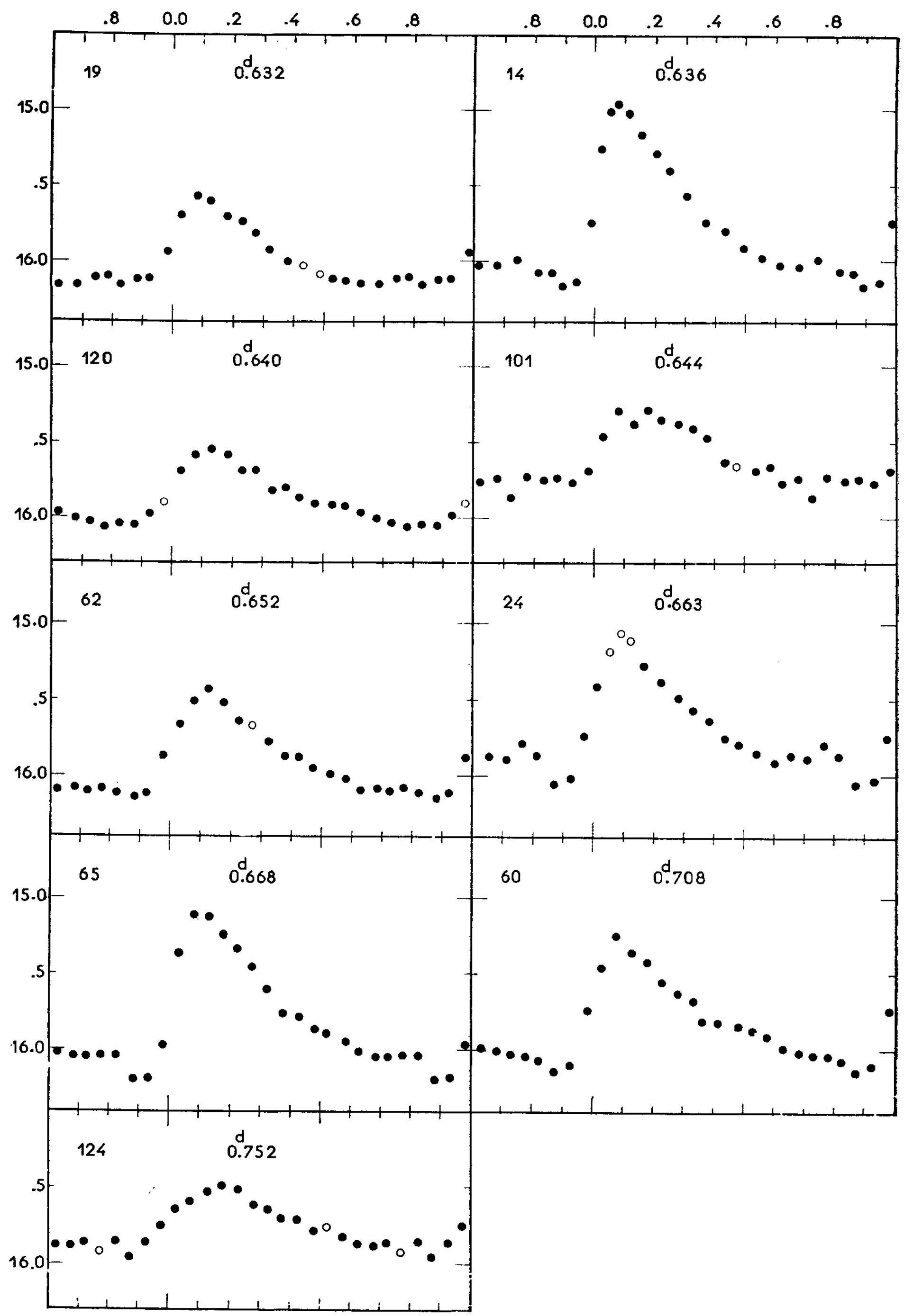

.8
0.0
.2
.4
.6
.8
19
0ᵈ.632
14
0ᵈ.636
120
0ᵈ.640
101
0ᵈ.644
62
0ᵈ.652
24
0ᵈ.663
65
0ᵈ.668
60
0ᵈ.708
124
0ᵈ.752
15.0
.5
16.0

Figure 27.

Table 9

OBSERVATIONS OF THE VARIABLES. (m—10)

J.D. 2 400 000 +	1	5	6	9	10	11	12
28 963.487	5.67	5.90	5.90	6.27	6.20	5.98	5.22
28 991.403	4.60	5.96	5.96	5.30	6.27	6.01	5.27
.416	4.85	6.06	5.46	5.58	6.06	5.81	5.21
.430	4.77	5.96	5.03	5.51	5.91	6.00	5.25
.522	4.90	5.75	5.13	6.05	5.19	6.12	5.04
.542	5.20	5.22	5.13	6.01	5.18	6.00	5.27
29 346.376	5.77	5.27	4.90	6.24	5.27	5.66	5.63
.392	5.81	5.69	5.23	6.26	5.44	5.77	5.85
29 719.549	5.70	6.16	5.97	6.07	5.97	4.83	5.44
.560	5.75	6.18	5.98	6.18	6.00	4.91	5.50
29 720.546	5.80	6.16	5.94	6.04	5.51	4.57	5.75
.558	5.72	6.07	6.09	6.07	5.47	4.66	5.69
29 774.405	4.73	5.90	5.68	5.36	6.13	4.73	5.30
.417	4.74	6.06	5.76	5.21	6.06	5.12	5.27
29 775.403	5.23	5.84	5.61	6.16	6.04	4.76	5.34
.415	4.84	5.97	5.65	6.17	6.15	4.77	5.20
.426	4.78	5.83	5.51	—	6.17	4.94	5.25
.437	4.80	5.88	5.69	6.34	6.10	5.11	5.33
.447	4.79	6.04	5.71	6.28	6.16	5.09	5.24
30 052.462	5.01	5.53	5.79	6.00	6.26	5.97	5.74
.474	5.20	5.26	5.26	6.00	5.79	6.15	5.83
.489	5.29	5.17	5.17	6.07	5.57	6.07	5.80
.501	5.32	5.13	4.95	6.12	5.38	6.24	6.08
30 078.418	4.81	5.46	6.03	5.88	6.14	6.22	5.23
.434	4.61	5.71	5.79	5.91	5.96	6.13	5.33
.470	5.08	5.97	5.97	6.00	6.00	6.02	5.49
.483	4.99	5.92	6.04	6.12	6.08	6.02	5.41
.498	5.03	5.87	5.98	5.94	6.07	5.98	5.47
.509	5.20	5.93	5.95	6.09	6.09	6.11	5.66
.521	5.36	5.99	5.97	6.07	6.13	6.13	5.79
.536	5.25	6.08	6.10	6.27	5.89	6.00	5.89
.548	5.26	5.96	6.07	6.07	5.94	5.98	5.82
33 390.497	5.90	6.14	5.05	5.38	5.13	6.34	5.66
.534	5.92	6.30	5.33	5.50	5.32	5.65	5.72
.545	5.95	6.00	5.33	5.69	5.25	5.25	5.75
.558	5.59	6.11	5.33	5.69	5.31	4.80	5.77
.570	5.33	6.17	5.62	5.69	5.62	4.81	5.69
.586	5.00	6.29	5.76	5.97	5.55	4.88	5.97
33 420.424	5.55	6.23	5.66	6.00	6.35	6.00	5.78
.438	5.70	6.26	5.78	5.95	6.15	6.24	6.12
.450	5.68	6.12	5.78	5.95	6.18	6.21	5.87
.476	5.62	5.98	5.64	6.01	5.98	6.09	5.93
.487	5.76	6.05	5.90	6.05	6.38	6.15	5.74
.498	5.75	5.77	5.75	5.96	6.12	5.96	5.73
.510	5.88	5.94	5.99	6.22	6.01	5.21	5.57
.523	5.78	—	—	5.99	5.94	4.77	5.16

Table 9 (continued)

J. D. 2 400 000 +	1	5	6	9	10	11	12
33 421.385	5.07	5.92	5.22	5.50	5.64	6.20	5.76
.442	5.42	5.97	5.46	5.85	5.92	6.04	5.87
.454	5.49	6.15	5.51	5.86	5.77	6.13	5.62
.465	5.42	6.05	5.66	5.84	5.80	6.11	5.48
.475	5.52	5.96	5.69	5.90	6.01	6.24	5.29
.486	5.65	6.05	5.82	5.89	6.02	6.22	5.19
.497	5.75	6.04	5.91	6.04	5.87	6.07	5.26
.535	5.79	6.16	5.98	5.98	6.18	5.03	5.29
.548	5.70	5.99	6.00	6.12	5.88	4.90	518
33 422.398	5.02	5.99	5.27	5.00	5.38	6.12	5.79
.431	5.22	6.13	5.36	5.32	5.44	6.33	5.47
.442	5.32	6.18	5.32	5.51	5.48	6.05	5.45
.452	5.33	6.16	5.46	5.37	5.46	5.95	5.46
.462	5.22	6.28	5.46	5.50	5.68	6.13	5.40
.472	5.57	6.09	5.66	5.55	5.60	6.43	5.36
.483	5.46	6.27	5.60	5.64	5.43	6.27	5.33
.493	5.42	6.00	5.59	5.54	5.72	6.31	5.27
.508	5.46	6.03	5.66	5.54	5.54	6.06	5.25
.520	5.50	5.89	5.72	5.61	5.50	6.08	5.30
33763.406	4.90	5.98	5.12	6.08	6.04	4.99	5.80
.420	5.03	5.94	5.23	6.13	5.99	5.18	5.75
.442	5.12	5.95	5.45	6.19	6.02	5.33	5.72
.455	5.27	6.07	5.49	6.07	6.23	5.41	5.89
.464	5.35	6.03	5.60	6.09	6.13	5.52	5.78
.483	5.35	6.15	5.60	6.25	6.05	5.58	5.85
.494	5.40	5.96	5.66	6.24	5.52	5.61	5.70
.504	5.48	6.14	5.72	6.20	5.50	5.67	5.64
.514	5.49	6.04	5.80	6.25	5.26	5.78	5.63
.525	5.65	5.91	5.84	6.07	5.19	5.77	5.56
34 118.355	—	5.88	5.63	5.19	5.11	5.06	5.22
.372	5.70	5.68	—	5.30	5.02	4.73	5.15
.388	5.36	5.91	5.59	5.31	5.00	4.45	5.04
.428	4.66	5.82	5.79	5.82	5.41	5.15	5.41
.443	4.80	6.04	5.88	5.79	5.60	5.30	5.46
.470	5.06	6.06	6.08	5.79	5.69	5.36	5.58
.485	5.06	5.92	5.98	6.02	5.59	5.52	5.59
.499	5.09	6.09	6.01	5.93	5.73	5.55	5.82
.513	5.19	5.98	—	6.10	5.80	5.60	5.67
.526	5.16	5.98	—	5.82	6.08	5.45	5.78
.540	5.33	6.06	5.99	6.35	5.86	5.95	5.95
34 120.471	5.45	5.93	5.76	5.03	6.04	5.22	5.79
. 484	5.01	6.07	5.83	5.03	6.30	5.27	5.81
.497	4.73	6.07	5.87	5.23	6.03	5.45	5.84
.510	4.73	6.19	5.80	5.26	6.26	5.40	5.76
.523	4.72	6.02	6.07	5.33	6.09	5.62	5.49
.536	4.88	6.00	5.98	5.48	6.13	5.60	5.39

Table 9 (continued)

J. D. 2 400 000 +	1	5	6	9	10	11	12
34 120.551	4.85	6.00	5.96	5.47	6.15	5.66	5.23
.564	5.04	6.13	6.09	5.69	6.11	5.71	5.31
.579	5.16	6.10	5.94	5.63	6.00	5.83	5.28
34 121.401	5.76	5.87	5.35	6.30	5.84	5.10	5.87
.412	5.79	5.98	5.20	6.17	5.98	4.77	5.74
.422	5.72	6.04	5.50	5.95	6.00	4.74	5.69
.431	5.85	5.81	5.42	5.92	5.99	4.75	5.61
.441	5.79	5.88	5.57	6.14	5.92	4.83	5.83
.484	5.86	5.93	5.64	6.13	5.99	5.23	5.59
.495	5.88	5.98	5.74	5.94	5.94	5.22	5.44
.505	5.69	5.96	5.73	5.69	6.06	5.35	5.32
.517	5.31	6.02	5.92	5.41	6.09	5.41	5.24
.528	4.94	5.92	5.83	5.10	6.01	5.57	5.40
.539	4.64	5.98	5.92	4.95	6.05	5.56	5.26
.552	4.68	6.14	5.97	4.99	6.17	5.70	5.27
.562	4.80	6.08	—	5.03	—	5.61	5.17
.594	4.92	5.97	5.92	5.25	6.08	5.66	5.12
.605	5.02	—	—	5.46	—	—	5.27
34 122.404	5.61	5.88	5.10	6.08	5.44	5.80	5.64
.416	5.87	5.78	5.13	6.13	5.47	5.16	5.58
.431	5.96	5.86	5.22	6.28	5.42	4.87	5.56
34 126.433	5.63	5.76	5.92	4.94	5.52	6.04	5.58
34 131.415	5.06	5.62	6.00	5.60	5.74	6.26	5.27
34 487.347	5.74	6.14	6.06	5.97	5.97	5.99	5.74
.367	5.89	6.10	5.91	6.16	5.76	6.10	5.57
.385	5.84	6.27	6.08	6.16	5.42	6.14	5.42
.397	5.66	6.16	5.86	6.09	5.14	6.12	5.17
.410	—	6.43	5.96	6.14	5.24	6.12	—
.428	—	5.95	5.96	6.15	5.07	6.11	—
.438	5.84	5.66	6.14	6.19	5.25	5.93	5.30
.449	6.03	5.67	6.13	6.19	5.39	6.19	5.35
.460	6.10	5.30	6.18	6.26	5.33	6.06	5.37
.474	5.80	5.14	6.26	6.35	5.29	6.33	5.19
.483	5.89	4.83	6.16	—	5.46	6.04	5.29
.494	—	4.69	5.92	—	5.53	6.39	5.38
.508	5.34	4.80	5.32	6.24	5.53	6.20	5.45
.518	5.07	4.90	5.07	6.09	5.72	6.10	5.60
34 488.530	5.79	5.00	5.59	5.97	5.30	6.21	5.81
.540	5.71	5.00	5.34	5.92	5.06	6.01	5.78
34 567.388	5.70	5.52	5.80	5.78	6.02	5.07	5.82
35 223.415	5.67	5.79	5.95	6.43	5.77	6.27	5.77
.428	5.75	5.84	6.00	6.22	5.92	6.13	5.81
.441	5.94	5.83	6.07	6.05	6.01	6.00	5.79
.467	5.80	5.76	6.10	6.19	5.97	6.04	5.78
.490	5.85	5.66	6.07	6.12	6.08	6.14	5.88
.503	5.81	5.50	5.65	6.07	6.09	6.11	5.54

Table 9 (continued)

J. D. 2 400 000 +	1	5	6	9	10	11	12
35 223.517	5.79	5.43	5.26	6.33	6.02	5.60	5.41
.530	5.81	5.45	4.89	6.30	6.01	4.96	5.24
.546	5.85	5.42	4.89	6.33	6.13	4.76	5.28
.573	5.83	5.48	5.07	5.83	6.22	4.82	5.18
35 224.454	5.88	5.72	6.02	6.21	5.44	6.13	5.63
.472	5.78	5.60	6.04	6.42	5.50	6.11	5.36
.485	5.77	5.53	6.10	6.24	5.59	6.16	5.26
.499	5.82	5.62	6.18	6.12	5.62	6.12	5.24
.512	5.84	5.42	6.32	6.30	5.63	6.14	5.21
.524	5.85	5.36	5.80	6.06	5.66	5.80	5.09
.542	5.86	5.41	5.22	6.14	5.79	5.04	5.22
.556	5.70	5.30	4.88	5.88	5.83	4.80	5.27
.569	5.82	5.48	4.80	5.99	5.74	4.73	5.34
.583	—	5.40	5.00	6.26	5.84	4.80	5.49
35 227.534	5.75	5.49	6.09	5.67	6.04	6.50	5.86
.547	—	5.48	6.12	5.78	6.22	6.26	5.80
.560	5.87	5.18	6.17	5.72	6.00	6.42	5.87
.573	5.71	5.16	6.23	5.82	6.04	6.23	6.04
.586	5.86	5.32	—	6.00	5.98	5.29	6.10
35 598.507	5.11	5.92	5.03	5.60	6.14	5.76	5.58
.524	4.82	5.86	5.18	5.74	5.79	5.63	5.92
.537	4.60	5.89	5.27	5.90	5.46	5.74	5.75
35 600.363	—	5.72	6.36	6.12	5.45	6.03	5.63
.378	5.80	5.66	6.15	6.06	5.45	5.40	5.50
.391	5.87	5.73	6.16	6.07	5.85	4.92	5.76
.405	5.86	5.66	5.82	6.02	5.70	4.66	5.71
.421	5.86	5.62	5.93	6.02	5.68	4.80	5.68
.434	5.86	5.71	5.86	6.06	5.79	4.90	5.82
.446	5.96	5.73	6.00	6.12	5.74	4.98	5.77
.501	5.93	5.71	6.00	5.85	6.04	5.44	5.78
.525	5.77	5.92	5.02	5.15	6.16	5.66	5.63
35 603.369	5.42	5.56	6.00	5.74	5.92	6.01	5.68
.381	5.66	5.66	5.98	5.84	6.25	6.27	5.84
.397	5.47	5.63	6.10	5.78	6.03	6.22	5.47
.408	5.59	5.52	6.02	5.75	6.04	5.95	5.30
.419	5.71	5.60	6.06	5.98	6.44	5.71	5.28
.431	5.68	5.60	6.26	5.94	6.06	5.28	5.43
.446	5.58	5.72	6.02	6.02	6.08	4.70	5.35
.457	—	5.73	6.24	6.06	6.19	4.70	5.32
.468	5.65	5.79	6.12	6.25	6.11	4.87	5.17
.491	5.73	5.75	6.14	6.02	6.04	4.96	5.23
.507	5.72	5.70	6.06	6.14	6.02	5.04	5.24
35 920.444	5.37	5.87	4.67	6.43	5.51	5.08	5.54
.467	5.53	6.20	4.91	6.11	5.60	5.40	5.47
.487	5.87	5.93	4.96	6.14	5.56	5.49	5.76
.504	5.50	5.91	5.08	6.09	5.76	5.54	5.66

Table 9 (continued)

J. D. 2 400 000 +	1	5	6	9	10	11	12
35 920.547	5.73	5.06	5.20	6.13	5.73	5.70	5.84
.562	—	4.82	5.38	5.80	5.88	5.73	5.62
.585	—	4.88	5.40	5.05	5.78	5.89	5.35
35 933.415	5.18	5.69	5.43	6.12	5.52	6.30	5.08
.443	5.54	5.90	5.74	6.13	4.88	5.98	5.30
.479	5.43	6.00	5.64	6.30	5.15	6.02	5.47
.503	5.50	6.08	5.80	6.23	5.06	6.08	5.41
.515	5.57	6.40	5.89	6.35	5.39	6.09	5.68
.530	5.69	6.33	5.86	6.22	5.43	6.03	5.55
.543	—	5.98	5.60	6.15	5.40	5.90	5.27
.573	5.81	5.98	6.05	5.41	5.53	4.78	5.68
.588	—	5.88	5.68	4.88	5.88	4.72	5.42
.602	—	5.73	5.76	4.80	—	4.80	5.41
36 991.457	6.15	5.06	5.87	5.93	—	5.93	5.79
.470	6.19	5.29	6.11	6.19	—	6.19	5.85
.485	6.01	5.22	6.32	5.93	6.04	6.03	5.83
37 018.470	5.83	5.98	6.20	5.69	5.47	4.99	5.70
.483	5.88	6.18	6.10	5.88	5.51	4.98	—
.496	5.78	5.90	5.94	5.69	5.30	5.30	5.78
.510	5.95	6.01	5.61	5.85	5.57	5.27	5.51
.523	5.96	5.99	5.20	5.89	5.64	5.51	5.22
.537	5.99	5.80	5.02	5.69	5.58	5.41	5.46
.550	5.78	—	5.02	6.00	5.69	5.46	5.29
.563	—	5.80	4.83	5.91	5.90	5.47	5.31
.577	5.84	6.12	5.18	6.06	5.84	5.76	5.35
.609	5.90	6.38	5.54	6.12	5.92	5.80	5.41
.623	5.84	6.24	5.63	6.42	6.14	5.87	5.46
.637	—	6.14	5.42	6.03	6.14	5.71	5.48
37 057.539	6.07	6.08	6.40	6.05	6.11	4.87	5.95
.552	6.16	5.92	6.27	6.04	5.98	4.80	5.85
.578	—	5.78	6.34	6.09	6.20	4.91	5.89
37 058.529	5.97	6.12	5.97	5.65	5.93	5.81	5.85
.580	—	5.79	6.40	6.26	—	4.89	5.64
37 757.598	5.15	6.22	5.54	5.11	6.05	5.95	5.33
37 791.365	4.43	5.92	6.03	6.18	5.49	6.14	5.49
.380	4.62	5.98	5.93	6.03	5.67	6.07	5.76
.394	4.89	5.97	5.96	6.08	5.68	6.19	5.67
.424	4.92	6.03	5.79	6.19	5.88	5.37	5.60
.439	—	6.06	5.97	6.08	5.82	4.90	5.78
.454	5.11	5.99	5.76	6.25	5.78	4.80	5.81
.469	5.35	5.61	5.71	6.10	5.85	5.00	5.62
.483	5.31	5.90	6.02	6.33	5.84	4.99	5.47
.497	5.30	5.82	5.93	6.27	5.80	5.11	5.22
.519	5.60	6.07	6.09	6.16	5.98	5.22	5.18
.533	5.47	5.90	6.04	6.38	6.12	5.44	5.19
.549	5.66	5.98	5.46	5.95	6.10	5.38	5.22
.563	5.73	5.89	5.12	6.23	6.16	5.46	5.33

Table 9 (continued)

J. D. 2 400 000 +	13	14	15	16	17	18	19
28 963.487	5.90	5.71	5.30	6.31	6.30	6.20	5.57
28 991.403	5.81	5.27	6.18	5.63	5.24	6.35	5.54
.416	5.78	5.64	—	5.78	5.22	6.20	5.72
.430	5.78	5.47	6.14	5.78	5.25	6.14	5.63
.522	5.58	5.75	4.72	6.12	5.46	5.96	6.06
.542	5.70	5.72	4.98	6.10	5.70	5.45	5.87
29 346.376	5.81	5.93	5.97	5.60	5.14	5.55	5.97
.392	5.81	5.91	6.12	5.73	5.71	5.81	6.36
29 719.549	5.70	5.60	6.02	6.39	6.24	6.51	6.02
.560	5.41	5.61	6.04	6.10	6.10	6.25	6.06
29 720.546	5.00	6.20	5.87	6.20	6.26	6.32	6.24
.558	4.78	6.03	5.88	6.29	6.29	6.29	5.86
29 774.405	5.74	6.10	5.86	4.90	5.22	5.24	5.80
.417	6.00	6.24	5.54	4.93	5.45	5.45	5.85
29 775.403	5.95	4.97	6.02	5.53	6.14	5.11	6.16
.514	6.00	5.13	6.17	5.20	6.17	5.13	6.23
.426	5.92	5.28	6.15	4.97	6.15	5.35	6.04
.437	5.90	5.26	6.15	5.08	6.29	5.39	6.12
.447	5.90	5.36	—	4.95	5.90	5.47	6.08
30 052.462	5.28	6.00	6.03	6.31	5.97	6.26	5.80
.474	5.23	5.95	6.15	6.33	6.19	6.35	5.65
.489	5.32	6.18	6.11	6.20	5.93	5.99	5.71
.501	5.48	6.22	6.26	6.22	6.15	6.69	6.01
30 078.418	5.90	6.05	5.99	5.97	6.03	6.03	5.86
.434	5.76	6.13	6.06	6.01	6.18	5.63	5.68
.470	5.24	6.00	6.00	5.97	6.13	5.32	5.91
.483	4.89	5.92	6.02	6.14	6.02	5.22	5.98
.498	4.87	5.92	6.12	5.92	5.83	5.27	6.00
.509	4.92	6.11	6.09	6.19	5.90	5.39	5.95
.521	5.06	6.03	6.16	6.24	5.79	5.62	5.99
.536	5.11	6.06	6.12	6.29	5.70	5.58	6.02
.548	5.03	6.18	6.07	6.14	5.66	5.60	6.02
33 390.497	5.92	5.07	6.14	6.34	6.14	6.47	5.87
.534	6.12	5.33	6.08	6.30	6.05	6.24	5.55
.545	5.98	5.29	6.20	6.37	6.22	6.37	5.64
.558	5.95	5.33	6.11	6.22	6.41	6.27	5.57
.570	5.87	5.60	6.05	6.17	6.05	6.17	5.69
.586	5.97	5.53	6.24	6.37	6.37	6.40	—
33 420.424	5.95	5.25	5.28	5.03	6.13	6.13	6.00
.438	6.12	5.37	5.52	5.16	6.05	6.26	—
.450	5.99	5.55	5.53	5.33	5.97	6.21	6.09
.476	5.93	5.45	5.66	5.45	6.13	6.31	6.07
.487	5.93	5.61	5.84	5.57	6.05	6.18	6.05
.498	5.73	5.50	5.92	5.56	6.31	6.31	6.08
.510	5.94	5.83	5.66	5.79	6.08	6.39	6.10
.523	5.80	5 62	5.86	5.76	—	6.15	6.17

Table 9 (continued)

J. D. 2 400 000 +	13	14	15	16	17	18	19
33 421.385	5.76	5.94	5.43	6.12	5.62	5.76	6.05
.442	6.07	6.10	5.03	5.01	5.73	6.15	5.85
.454	5.99	5.95	5.22	5.15	5.68	6.00	5.70
.465	5.82	6.15	5.38	5.21	5.88	5.97	5.59
.475	5.89	6.12	5.37	5.29	5.83	6.13	5.70
.486	6.05	6.26	5.41	5.39	5.85	6.29	5.59
.497	6.07	6.13	5.53	5.50	5.75	6.40	5.51
.535	6.31	6.27	5.79	5.63	6.24	6.41	5.72
.548	5.88	—	5.86	5.70	6.22	6.40	5.66
33 422.398	6.12	5.71	6.34	6.37	6.10	5.74	6.14
.431	6.08	5.80	6.03	5.44	5.59	5.65	6.11
.442	5.99	5.76	5.63	5.05	5.57	6.10	6.22
.452	5.99	5.76	5.26	4.96	5.46	6.20	6.23
.462	6.09	5.78	4.95	5.01	5.22	6.05	6.09
.472	6.06	5.77	—	5.09	5.60	6.32	6.06
.483	5.98	5.95	4.95	5.08	5.49	6.24	—
.493	6.08	5.90	4.99	5.27	5.59	6.21	6.17
.508	5.99	5.69	5.11	5.30	5.43	6.27	6.25
.520	5.78	5.89	5.24	5.50	5.61	6.60	6.12
33 763.406	6.00	5.91	5.48	6.26	6.18	6.24	5.72
.420	5.99	5.94	5.60	6.22	6.08	6.20	5.60
.442	6.02	6.02	5.64	6.17	6.06	6.20	5.68
.455	6.10	5.98	5.85	6.32	6.39	6.12	5.66
.464	6.09	5.99	5.78	6.21	6.28	6.38	5.76
.483	5.96	6.05	5.80	6.29	6.23	6.17	5.87
.494	5.88	6.08	5.81	6.15	6.11	6.31	5.79
.504	6.02	6.02	5.83	6.16	6.25	6.41	5.81
.514	6.02	6.02	5.85	6.19	5.85	6.38	5.88
.525	6.13	6.15	5.98	6.40	5.61	6.23	5.98
34 118.355	5.76	5.88	5.97	6.12	6.16	5.00	5.96
.372	5.68	5.83	5.98	6.41	6.11	5.20	5.90
.388	5.87	6.00	6.10	6.22	5.80	5.22	—
.428	5.99	6.18	6.18	6.31	5.41	5.55	5.99
.443	5.88	6.14	5.43	6.17	5.43	5.80	6.14
.470	—	6.01	4.82	6.16	5.32	5.94	—
.485	5.92	6.14	5.10	6.21	5.59	5.92	5.86
.499	5.93	5.93	4.99	6.21	5.45	5.99	5.82
.513	5.82	5.64	5.22	6.26	5.67	6.12	5.67
.526	5.86	5.22	5.16	6.04	5.62	5.98	5.80
.540	5.99	5.22	5.37	6.47	5.77	6.35	5.71
34 120.471	5.95	4.96	6.11	6.17	6.11	5.67	5.56
.484	5.81	4.95	6.12	6.14	6.07	5.75	5.60
.497	5.96	5.03	6.03	6.33	6.14	5.78	5.73
.510	6.04	5.06	6.20	6.26	6.06	5.76	5.70
.523	5.94	5.28	6.26	6.23	6.09	5.82	5.77
.536	5.95	5.19	6.28	6.18	6.09	5.97	5.57

Table 9 (continued)

J. D. 2 400 000 +	13	14	15	16	17	18	19
34 120.551	5.68	5.25	5.94	6.24	6.15	6.00	5.66
.564	5.63	5.34	5.40	6.33	6.13	6.05	5.75
.579	5.04	5.28	4.88	6.24	6.16	6.12	5.92
34 121.401	5.84	5.78	6.12	6.30	5.44	5.02	6.31
.412	5.91	5.95	—	—	5.61	4.91	6.10
.422	5.95	5.95	6.04	6.30	5.66	5.02	6.20
.431	6.00	5.92	6.10	6.16	5.59	5.09	6.12
.441	5.92	6.02	6.16	6.26	5.76	5.18	6.14
.484	6.02	5.95	6.06	6.11	5.75	5.46	6.02
.495	5.98	5.96	6.11	6.15	5.92	5.58	6.05
.505	5.88	5.97	6.07	5.96	5.96	5.66	6.12
.517	6.00	6.14	6.12	6.19	5.94	5.63	6.14
.528	5.73	5.94	6.12	6.04	5.92	5.74	6.07
.539	5.22	6.11	6.05	6.14	5.90	5.70	6.33
.552	4.83	5.97	6.06	6.26	6.02	5.79	6.20
.562	4.63	—	—	6.08	6.08	5.73	6.12
.594	4.86	6.06	6.14	6.10	6.06	5.94	6.16
.605	5.11	—	—	—	6.00	5.83	—
34 122.404	—	5.00	5.92	5.94	6.06	—	5.74
.416	5.74	5.08	6.29	5.94	5.96	5.43	5 65
.431	6.04	5.22	6.17	6.15	5.88	5.04	5.68
34 126.433	5.07	5.68	5.94	5.86	6.00	6.16	6.06
34 131.415	5.80	5.56	5.96	4.94	6.17	6.26	6.34
34 487.347	5.58	5.58	6.14	6.20	5.97	5.97	6.22
.367	5.69	5.36	5.94	5.82	6.12	6.38	6.12
.385	5.99	4.96	5.26	5.32	6.06	6.30	6.12
.397	5.82	4.90	4.92	4.98	—	—	6.01
.410	6.10	5.04	4.90	5.01	6.10	6.20	6.27
.428	—	4.90	4.95	5.01	6.12	6.20	6.02
.438	5.93	5.12	5.06	5.12	5.93	6.20	6.00
.449	5.93	5.24	5.19	5.32	6.28	6.15	6.36
.460	6.02	5.23	5.33	5.37	6.32	6.14	6.25
.474	5.90	5.31	5.29	5.45	—	5.93	6.24
.483	5.87	5.25	5.44	5.56	—	5.72	6.03
.494	—	5.40	5.48	5.61	—	5.48	—
.508	6.04	5.55	5.47	5.78	—	5.34	—
.518	6.04	5.59	5.61	5.82	—	5.37	—
34 488.530	5.91	6.09	5.30	5.71	5.93	5.56	6.11
.540	5.90	6.12	5.48	5.66	5.97	5.46	6.13
34 567.388	5.32	—	6.41	6.00	5.80	6.08	5.91
35 223.415	5.26	5.99	—	6.05	6.16	5.31	5.90
.428	5.25	5.92	6.13	5.56	6.05	5.32	6.03
.441	5.37	6.05	6.21	5.32	6.00	5.43	6.00
.467	5.32	5.97	6.17	4.95	5.64	5.55	5.99
.490	5.64	6.04	6.19	5.22	5.57	5.72	6.10
.503	5.62	6.07	6.20	5.33	5.33	5.77	6.11

Table 9 (continued)

J. D. 2 400 000 +	13	14	15	16	17	18	19
35 223.517	5.77	6.06	6.20	5.45	5.34	5.89	6.08
.530	5.97	6.07	6.24	5.49	5.47	5.93	6.26
.546	5.79	6.04	6.11	5.69	5.45	5.98	6.11
.573	5.67	5.95	6.14	5.75	5.45	5.89	6.05
35 224.454	5.49	5.12	6.00	5.54	6.10	5.29	5.90
.472	5.54	5.16	6.23	4.92	6.30	5.35	5.66
.485	5.59	5.19	6.14	4.95	6.10	5.44	5.70
.499	5.62	5.27	6.15	5.02	6.08	5.62	5.73
.512	5.60	5.32	6.32	5.18	6.12	5.64	5.58
.524	5.52	5.26	6.14	5.21	6.13	5.52	5.50
.542	5.77	5.39	6.01	5.39	6.20	5.70	5.65
.556	5.70	5.56	6.12	5.53	6.16	5.79	5.48
.569	5.85	5.67	6.12	5.56	6.24	6.12	5.85
.583	5.94	5.84	6.20	5.64	6.06	6.10	5.64
35 227.534	6.45	5.75	5.64	5.15	5.35	5.29	5.94
.547	6.24	5.38	5.85	4.99	5.40	—	6.14
.560	6.27	5.18	5.86	5.02	5.36	5.45	6.14
.573	5.76	4.82	—	5.16	5.56	5.67	5.98
.586	6.08	4.89	6.03	5.10	5.68	5.55	6.00
35 598.507	5.76	5.62	5.20	5.78	6.16	6.09	—
.524	5.88	5.77	5.34	5.81	5.98	6.26	6.19
.537	5.89	5.90	5.40	5.96	5.58	6.38	6.32
35 600.363	6.03	5.64	6.21	6.13	5.52	5.04	6.38
.378	5.72	5.52	6.45	6.17	5.55	5.11	6.07
.391	5.93	5.58	6.16	6.28	5.78	5.34	6.28
.405	5.80	5.55	6.28	5.66	5.84	5.32	—
.421	5.95	5.66	5.93	5.09	5.66	5.52	6.27
.434	5.71	5.77	6.23	4.92	5.69	5.58	6.19
.446	5.87	5.68	6.05	4.98	5.83	5.66	6.07
.501	5.74	6.05	6.07	5.36	6.09	6.10	5.90
.525	6.03	6.14	6.16	5.54	5.97	6.07	5.75
35 603.369	5.80	5.18	5.86	6.35	5.96	6.38	6.15
.381	5.80	5.17	5.86	6.20	5.80	6.70	6.31
.397	5.80	4.92	5.86	6.28	5.91	6.33	6.22
.408	5.73	4.98	5.86	6.15	5.95	5.67	6.02
.419	5.82	5.11	5.90	6.40	6.01	5.43	6.26
.431	5.90	5.05	6.00	6.24	6.02	4.95	6.04
.446	5.72	5.08	6.06	6.27	6.02	4.87	6.18
.457	5.78	5.20	6.02	6.37	6.22	4.94	6.24
.468	5.46	5.22	6.09	5.92	5.98	5.06	6.04
.491	5.08	5.35	5.91	5.08	5.82	5.17	6.10
.507	4.94	5.34	6.30	4.94	6.04	5.39	6.14
35 920.444	4.96	5.87	6.05	6.23	6.22	5.99	5.65
.467	5.36	5.97	5.97	6.11	6.22	6.05	5.67
.487	5.67	—	5.77	5.92	6.04	5.51	5.72
.504	5.42	5.97	6.08	6.12	6.02	5.38	5.86

Table 9 (continued)

J. D. 2 400 000 +	13	14	15	16	17	18	19
35 920.547	5.56	5.87	6.13	6.26	6.26	5.20	5.97
.562	5.38	5.83	6.19	6.42	6.19	5.25	5.92
.585	5.55	6.00	6.02	6.16	6.05	5.43	5.95
35 933.415	4.69	5.04	6.21	4.82	5.69	5.08	6.04
.443	4.88	5.08	5.59	4.93	5.86	4.90	6.24
.479	5.00	5.00	4.97	5.36	5.95	5.33	5.98
.503	5.11	5.11	4.89	5.44	5.67	4.89	5.90
.515	5.50	—	5.39	5.68	5.99	5.47	6.13
.530	5.46	5.24	5.24	5.72	5.69	5.63	6.08
.543	5.19	5.36	5.39	5.94	5.96	5.94	6.07
.573	5.53	5.48	5.41	5.95	5.95	5.93	—
.588	5.30	5.67	5.44	5.87	6.05	—	5.96
.602	—	—	5.46	—	—	—	5.41
36 991.457	6.05	6.31	6.07	6.05	6.16	6.16	5.72
.470	6.16	—	6.09	6.16	6.43	6.84	5.66
.485	6.08	6.08	5.53	6.03	6.32	5.96	5.88
37 018.470	5.72	5.85	6.13	5.78	5.93	5.21	6.24
.483	5.86	5.78	6.27	6.05	5.92	5.15	6.06
.496	5.82	5.66	6.27	—	6.09	5.34	6.14
.510	5.68	5.92	5.86	6.08	6.05	5.58	6.24
.523	5.70	5.99	5.15	6.00	6.12	5.58	6.18
.537	5.70	5.90	4.90	5.96	6.02	5.73	6.18
.550	5.77	5.92	4.96	5.91	5.71	5.64	6.19
.563	5.50	—	5.03	6.42	6.16	5.78	6.12
.577	5.95	5.81	5.24	6.08	6.24	5.67	6.12
.609	5.86	6.00	5.31	6.32	6.17	6.00	5.86
.623	6.22	6.04	5.40	—	6.12	5.94	6.06
.637	6.00	6.14	5.48	6.06	6.29	6.35	5.90
37 057.539	5.57	6.15	6.15	6.36	5.57	6.27	6.11
.552	5.53	6.22	6.31	6.33	5.71	6.27	6.10
.578	5.78	6.45	6.25	6.19	6.12	6.25	6.12
37 058.529	5.78	5.69	6.01	6.26	6.05	6.33	5.65
.580	6.06	—	6.40	6.20	5.14	6.45	5.83
37 757.598	—	5.98	5.63	5.74	5.63	5.86	5.92
37 791.365	5.49	5.96	6.14	5.89	5.73	6.25	6.25
.380	5.72	5.91	5.61	5.93	5.56	6.33	6.13
.394	5.71	5.93	5.08	5.98	5.42	6.21	6.04
.424	5.86	5.94	4.88	6.15	5.37	6.20	6.03
.439	5.84	6.05	5.11	6.16	5.42	6.38	6.20
.454	5.64	6.19	5.20	6.19	5.47	6.29	6.06
.469	5.73	5.96	5.32	6.30	5.54	6.34	6.20
.483	5.65	5.60	5.28	6.35	5.65	6.11	6.02
.497	5.60	5.33	5.52	6.27	5.69	5.75	6.10
.519	5.77	5.13	5.60	6.21	5.70	5.00	6.16
.533	5.74	5.03	5.64	6.20	5.77	4.92	6.15
.549	5.72	4.99	5.66	6.26	5.81	5.07	5.86
.563	5.76	5.12	5.80	6.26	5.86	5.12	5.73

Table 9 (continued)

J. D. 2 400 000 +	20	21	22	23	24	25	26
28 963.487	5.84	6.22	6.13	5.78	5.75	5.98	5.71
28 991.403	5.57	6.12	6.12	5.57	5.83	5.83	5.72
.416	5.91	6.15	6.19	5.64	5.75	5.75	5.81
.430	5.75	6.14	6.04	5.60	5.78	5.60	5.63
.522	6.10	5.76	5.04	5.54	5.84	4.47	5.64
.542	6.04	5.14	4.83	5.47	5.80	4.58	5.61
29 346.376	5.97	4.81	4.84	5.42	5.86	5.42	5.33
.392	6.40	5.18	5.21	5.26	5.91	5.66	5.61
29 719.549	6.21	6.33	5.70	5.70	5.38	6.09	5.90
.560	6.21	6.18	5.85	5.72	5.58	5.93	5.89
29 720.546	6.22	6.32	5.92	5.54	5.92	5.94	5.30
.558	6.19	6.29	5.85	5.62	5.86	5.88	5.34
29 774.405	5.22	5.96	5.41	5.80	5.74	6.03	5.38
.417	5.42	5.80	5.54	5.70	5.41	5.91	5.51
29 775.403	5.23	6.59	5.72	5.63	5.84	5.05	4.78
.415	5.25	6.41	5.59	5.76	5.83	4.71	4.84
.426	5.51	6.10	5.81	5.65	5.72	4.68	4.94
.437	5.61	5.73	5.95	5.71	5.90	4.60	5.00
.447	5.64	5.60	5.97	5.83	5.97	4.89	4.95
30 052.462	5.01	5.28	6.00	5.77	5.28	5.01	5.87
.474	5.06	5.46	6.00	5.79	5.31	5.20	5.80
.489	5.29	5.48	6.18	5.71	5.43	5.17	5.82
.501	5.45	5.66	6.10	5.45	5.42	5.32	6.01
30 078.418	5.38	6.20	6.20	5.79	5.59	5.32	5.41
.434	5.09	6.04	6.11	5.65	5.49	5.39	5.01
.470	5.27	6.24	6.07	5.64	5.59	5.54	5.00
.483	5.29	6.14	6.12	5.88	5.62	5.62	4.95
.498	5.30	6.18	6.06	5.70	5.69	5.66	5.07
.509	5.51	6.53	5.95	5.60	5.69	5.69	5.11
.521	5.70	6.21	6.01	5.79	5.79	5.91	5.16
.536	5.79	6.20	5.66	5.58	5.70	5.79	5.20
.548	5.80	6.27	5.60	5.69	5.80	5.89	5.16
33 390.497	5.02	—	6.16	5.62	5.40	—	5.94
.534	5.25	5.92	6.12	5.85	5.60	6.12	5.16
.545	5.39	6.22	6.15	5.69	5.54	6.12	4.99
.558	5.43	6.20	6.11	5.66	5.48	6.07	4.85
.570	5.47	6.17	6.17	5.69	5.71	6.05	4.98
.586	5.74	6.24	6.26	5.81	5.55	5.97	5.18
33 420.424	4.97	6.23	6.72	5.66	5.66	6.16	5.06
.438	5.21	6.26	6.32	5.81	5.81	5.75	4.97
.450	5.29	6.16	6.19	5.83	5.68	5.19	4.91
.476	5.24	6.18	6.18	5.74	5.80	4.75	5.04
.487	5.48	6.35	6.09	5.74	5.74	4.90	5.31
.498	5.30	6.52	6.30	5.75	5.81	4.81	5.30
.510	5.45	6.35	6.22	5.90	5.85	5.05	5.26
.523	5.78	—	5.78	5.76	6.00	5.14	5.25

Table 9 (continued)

J. D. 2 400 000 +	20	21	22	23	24	25	26
33 421.385	5.24	5.89	6.00	5.50	5.89	5.96	5.92
.442	5.35	6.02	6.26	5.68	6.00	4.78	5.95
.454	5.30	6.21	5.99	5.68	6.00	4.86	5.90
.465	5.27	6.13	5.92	5.66	6.05	4.94	5.92
.475	5.34	6.20	6.01	5.72	6.12	5.05	5.94
.486	5.57	6.41	5.99	5.80	5.89	5.01	5.89
.497	5.47	6.30	5.67	5.67	5.75	5.28	6.00
.535	5.70	6.51	5.05	5.79	5.32	5.52	6.10
.548	5.88	6.40	4.90	6.00	5.18	5.60	6.24
33 422.398	5.24	5.89	6.46	5.03	5.71	4.79	5.69
.431	5.20	5.95	6.11	5.25	5.65	5.10	5.80
.442	5.54	6.05	6.08	5.29	5.70	5.25	5.60
.452	5.43	5.95	5.95	5.26	5.73	5.20	5.95
.462	5.37	5.87	5.60	5.31	5.78	5.22	5.78
.472	5.45	5.93	5.12	5.28	5.77	5.39	5.80
.483	5.54	6.30	5.29	5.22	5.78	5.26	5.92
.493	5.72	6.26	5.14	5.54	5.73	5.38	5.85
.508	5.69	6.41	4.95	5.41	5.92	5.46	5.83
.520	5.76	5.91	5.00	5.43	5.78	5.64	5.91
33 763.406	5.65	6.29	5.45	5.65	5.65	5.78	5.80
.420	5.69	6.10	5.57	5.77	5.80	5.77	5.97
.442	5.73	—	5.73	5.75	5.75	5.88	5.99
.455	5.92	6.35	5.94	5.71	5.81	5.98	6.03
.464	5.89	6.23	5.84	5.52	5.80	6.01	5.99
.483	6.06	6.25	5.94	5.51	5.87	6.06	5.87
.494	5.91	6.22	5.88	5.40	5.83	5.96	5.66
.504	5.99	6.23	6.02	5.40	5.87	5.99	5.40
.514	6.04	6.38	6.10	5.42	5.85	6.02	5.26
.525	5.98	6.17	6.02	5.24	5.91	6.05	5.22
34 118.355	6.12	6.22	5.97	5.34	5.88	5.97	5.78
.372	5.98	6.25	5.90	5.20	5.77	5.94	—
.388	6.18	6.20	6.20	4.90	5.91	6.03	5.95
.428	6.02	6.22	6.20	4.98	5.79	5.79	5.95
.443	6.14	6.40	6.14	5.24	5.95	5.53	5.92
.470	5.50	6.34	6.34	5.36	5.94	4.64	—
.485	5.44	5.59	6.04	5.21	5.89	4.68	6.02
.499	4.95	5.20	6.28	5.45	5.93	4.82	5.87
.513	4.80	4.98	6.18	5.47	5.84	5.00	5.99
.526	4.92	4.92	—	5.68	5.57	4.92	—
.540	4.88	5.08	6.22	5.48	6.06	5.15	5.95
34 120.471	4.87	5.89	6.17	5.67	5.79	5.18	5.09
.484	4.89	6.24	6.12	5.87	5.96	5.45	5.27
.497	4.90	6.33	6.07	5.84	5.73	5.41	5.45
.510	5.06	6.38	5.98	5.86	5.82	5.55	5.38
.523	5.19	6.36	5.61	5.86	5.80	5.52	5.36
.536	5.19	6.08	5.39	5.80	5.72	5.75	5.57

Table 9 (continued)

J. D. 2 400 000 +	20	21	22	23	24	25	26
34 120.551	5.20	5.59	5.25	5.77	5.94	5.66	5.50
.564	5.50	5.15	5.18	5.86	6.02	5.78	5.52
.579	5.55	4.90	5.00	5.83	6.00	5.83	5.83
34 121.401	5.87	6.30	—	5.14	5.04	5.07	—
.412	5.79	—	6.40	5.18	5.09	5.09	6.08
.422	5.53	6.56	6.28	5.18	5.14	5.27	5.92
.431	5.32	6.16	6.15	5.24	5.03	5.24	5.96
.441	5.10	6.14	6.16	5.38	5.18	5.46	5.85
.484	4.95	6.26	5.80	5.46	5.34	5.65	5.86
.495	5.10	6.52	5.67	5.51	5.26	5.64	5.98
.505	5.28	6.21	5.48	5.59	5.44	5.67	5.96
.517	5.32	6.18	5.24	5.54	5.45	5.86	—
.528	5.30	6.22	5.14	5.54	5.42	5.74	5.92
.539	5.59	6.25	5.06	5.48	5.59	5.75	5.92
.552	5.44	6.39	5.08	5.59	5.44	5.87	5.70
.562	5.63	—	5.12	5.50	5.46	5.78	—
.594	5.80	5.22	5.12	5.69	5.49	5.80	—
.605	5.71	5.02	5.22	5.66	—	—	4.83
34 122.404	5.76	6.12	5.95	5.72	5.84	5.48	—
.416	5.20	6.46	6.42	5.76	5.70	5.31	—
.431	4.87	6.17	6.08	5.76	5.76	5.50	5.71
34 126.433	5.45	5.85	5.47	5.78	5.84	6.00	5.08
34 131.415	5.98	5.06	6.22	5.85	5.30	4.86	—
34 487.347	6.14	5.41	5.84	5.74	5.88	5.92	5.99
.367	6.18	5.62	5.57	5.78	5.64	5.94	5.67
.385	6.03	5.74	5.26	5.79	5.91	5.99	5.30
.397	5.72	5.68	5.02	5.66	5.66	6.07	5.02
.410	6.03	5.90	5.13	5.80	6.01	6.09	4.98
.428	5.18	5.86	5.12	5.78	6.00	5.86	4.88
.438	4.79	5.93	5.30	5.64	5.93	5.95	5.02
.449	4.89	6.09	5.32	5.60	6.20	6.05	5.10
.460	4.86	6.12	5.37	5.37	6.02	6.10	5.10
.474	4.97	6.06	5.41	5.42	5.90	5.90	5.19
.483	5.02	6.01	5.61	5.24	5.83	6.09	5.23
.494	5.19	—	5.64	5.21	5.78	5.92	5.38
.508	5.33	6.37	5.78	5.14	5.50	5.87	5.26
.518	5.50	6.13	5.85	5.22	5.43	6.04	5.41
34 488.530	5.68	6.14	6.04	5.75	5.89	6.08	6.01
.540	5.78	6.18	5.92	5.77	5.76	5.82	5.78
34 567.388	5.98	5.93	5.45	5.39	5.74	5.20	5.89
35 223.415	5.77	6.12	6.16	5.09	5.67	5.93	5.56
.428	5.92	6.20	6.14	5.09	5.62	5.92	5.64
.441	5.81	6.10	6.20	5.17	5.59	5.94	5.59
.467	6.02	6.14	5.69	5.22	5.71	5.86	5.60
.490	6.06	6.35	5.27	5.29	5.80	6.04	5.79
.503	6.18	6.13	5.07	5.40	5.69	6.02	5.79

Table 9 (continued)

J. D. 2 400 000 +	20	21	22	23	24	25	26
35 223.517	5.89	6.14	4.93	—	5.79	5.85	5.94
.530	6.19	6.28	5.01	5.38	5.75	5.24	5.81
.546	6.13	6.26	5.08	5.51	5.83	4.73	5.77
.573	6.17	6.36	5.20	5.50	5.83	4.77	5.87
35 224.454	5.93	5.86	5.24	5.60	5.98	6.12	4.93
.472	6.01	6.09	4.86	5.70	5.83	5.88	5.00
.485	6.06	6.04	4.81	5.85	5.59	5.44	5.14
.499	6.06	6.18	4.90	5.84	5.50	5.02	5.22
.512	6.03	6.14	5.05	5.72	5.40	4.71	5.30
.524	5.98	5.90	5.09	5.76	5.21	4.70	5.23
.542	6.33	6.16	5.24	5.56	5.14	4.85	5.37
.556	6.34	6.43	5.46	5.30	5.04	4.98	5.43
.569	6.39	6.39	5.56	5.23	5.10	5.15	5.51
.583	6.36	6.22	5.59	5.06	5.17	5.32	—
35 227.534	6.45	5.88	6.26	5.18	6.21	6.04	5.62
.547	6.28	6.44	5.90	5.12	6.12	5.70	5.51
.560	6.60	5.87	6.42	5.05	6.06	6.06	5.67
.573	6.04	6.28	5.94	4.97	5.78	5.78	5.51
.586	6.03	5.90	5.88	4.85	6.21	5.84	5.76
35 598..507	6.26	6.45	5.14	5.14	6.06	4.94	6.06
.524	6.26	6.27	5.07	5.27	5.99	5.15	6.16
.537	6.10	6.00	5.04	5.14	6.20	5.32	6.20
35 600.363	6.34	5.71	6.31	5.24	6.01	5.88	5.72
.378	6.20	5.64	5.75	5.04	5.84	5.02	5.38
.391	6.28	5.87	5.93	5.36	5.78	4.73	5.10
.405	6.62	5.88	5.68	5.42	5.92	4.73	4.78
.421	6.08	5.90	5.46	5.46	5.93	4.86	4.93
.434	5.88	5.66	5.10	5.32	5.73	5.05	5.10
.446	6.07	5.87	4.95	5.57	5.87	5.17	5.04
.501	6.07	6.10	5.23	5.47	5.88	5.41	5.26
.525	5.75	6.47	5.52	5.75	5.90	5.41	5.52
35 603.369	6.38	5.15	5.01	5.42	5.16	5.20	5.20
.381	6.50	5.33	5.00	5.66	5.25	5.55	5.14
.397	6.46	5.34	5.24	5.57	5.32	5.47	4.89
.408	6.15	5.39	5.27	5.41	5.30	5.50	4.92
.419	6.21	5.67	5.56	5.54	5.38	5.54	5.11
.431	6.06	5.65	5.52	5.58	5.49	5.82	5.05
.446	6.06	5.72	5.53	5.47	5.32	5.84	5.08
.457	5.91	5.78	5.59	5.57	5.47	5.94	5.15
.468	5.60	5.67	5.79	5.57	5.46	5.92	5.20
.491	5.37	5.71	5.87	5.58	5.42	5.87	5.37
.507	5.18	5.94	5.94	5.77	5.51	5.77	5.48
35 920.444	4.91	6.17	6.11	5.80	4.86	5.79	5.39
.467	5.24	6.22	6.00	5.76	5.15	5.87	5.67
.487	5.46	5.62	—	5.62	5.34	5.70	5.85
.504	5.66	5.26	5.91	5.42	5.08	5.66	5.73

Table 9 (continued)

J. D. 2 400 000 +	20	21	22	23	24	25	26
35 920.547	5.80	4.96	5.40	5.37	5.29	5.77	5.53
.562	5.98	5.13	5.00	5.20	5.13	5.38	5.62
.585	5.95	5.12	4.64	5.12	5.21	4.47	5.66
35 933.415	5.93	4.79	5.84	5.66	5.82	5.84	5.22
.443	6.18	4.93	5.99	5.71	5.83	6.01	5.14
.479	6.10	5.43	5.95	5.67	5.74	5.84	5.47
.503	5.86	5.30	5.83	5.56	6.00	5.88	5.27
.515	6.16	5.80	5.89	5.68	5.99	5.85	5.41
.530	6.29	5.66	5.74	5.86	6.08	5.30	5.49
.543	—	5.81	5.40	5.90	—	4.52	5.36
.573	5.88	5.95	4.97	5.85	5.98	4.64	5.62
.588	5.61	6.01	5.03	5.62	5.72	4.88	—
.602	5.68	6.17	4.88	5.96	5.66	4.80	—
36 991.457	5.84	6.30	5.63	5.72	6.13	6.13	—
.470	6.09	6.61	6.32	5.91	6.16	6.43	5.61
.485	5.96	6.16	—	5.83	5.93	6.17	5.60
37 018.470	5.70	6.20	6.13	5.04	5.82	5.01	5.61
.483	5.82	6.30	6.21	5.04	5.81	4.66	5.86
.496	6.02	6.49	—	5.11	5.75	4.74	5.78
.510	5.97	5.84	6.22	5.14	5.76	5.02	5.86
.523	6.01	5.38	6.04	5.29	5.70	5.04	5.80
.537	5.75	5.03	6.03	5.16	5.57	5.32	5.62
.550	6.13	5.08	6.11	5.36	5.92	5.20	5.68
.563	5.90	5.06	—	5.52	6.08	5.31	5.74
.577	6.10	5.20	6.16	5.47	6.02	5.62	5.95
.609	6.20	5.48	5.92	5.48	5.98	5.60	5.88
.623	6.27	5.61	6.06	5.72	5.84	5.94	5.99
.637	6.03	5.82	5.77	5.58	6.00	6.00	5.96
37 057.539	6.21	6.41	6.33	5.95	5.47	6.05	5.97
.552	6.16	6.39	6.06	5.65	5.57	5.75	6.01
.578	5.98	6.40	6.25	5.84	5.34	6.29	6.09
37 058.**529**	6.05	6.29	6.19	5.55	6.01	5.93	5.78
.580	6.15	6.29	6.36	5.73	6.36	6.40	6.15
37 757.598	—	5.00	6.11	5.88	5.88	5.70	—
37 791.365	6.25	6.21	4.86	5.25	5.60	4.49	5.69
.380	6.26	6.16	5.11	5.46	5.81	4.45	5.67
.394	6.25	6.11	5.27	5.41	5.85	4.77	5.68
.424	6.27	6.23	5.38	5.48	5.60	4.71	5.80
.439	6.58	6.24	5.54	5.60	5.91	5.07	5.87
.454	6.22	6.29	5.47	5.60	5.60	4.95	6.06
.469	6.24	6.34	5.63	5.66	5.93	5.19	6.02
.483	6.02	6.30	5.60	5.65	5.69	5.34	5.74
.497	6.22	6.28	5.60	5.55	5.75	5.40	5.81
.519	6.27	6.21	5.98	5.85	5.90	5.64	5.90
.533	6.28	6.23	5.82	5.71	5.90	5.68	5.90
.549	5.62	6.20	5.98	5.66	5.92	5.77	5.86
.563	5.02	6.34	6.03	5.86	6.18	5.82	6.09

Table 9 (continued)

J. D. 2 400 000 +	27	28	31	32	33	34	35
28 963.487	5.90	5.75	4.30	5.80	5.60	5.10	6.07
28 991.403	5.96	4.88	4.60,	5.44	5.67	5.54	6.18
.416	5.96	4.90	4.40	5.28	5.64	5.34	6.06
.430	6.06	4.80	4.53	5.29	5.71	5.22	6.17
.522	5.97	4.81	—	—	5.45	5.26	6.03
.542	6.12	5.06	—	4.15	5.53	5.45	6.05
29 346.376	5.97	5.45	5.09	4.96	5.52	5.69	5.97
•392	6.09	5.66	5.15	—	5.85	5.57	6.14
29 719.549	5.11	5.24	4.91	5.67	5.55	5.88	6.21
.560	5.01	5.30	4.75	5.72	5.30	5.79	6.04
29 720.546	6.04	5.39	5.21	5.51	5.85	5.21	6.07
.558	5.88	5.26	5.26	5.36	5.79	5.41	5.97
29 774.405	6.13	5.55	5.33	5.61	5.58	6.28	5.38
.417	6.06	5.60	5.45	5.85	5.60	6.22	5.76
29 775.403	5.98	5.63	4.87	5.48	5.43	5.63	5.11
.415	5.94	5.47	4.90	5.49	5.49	5.76	5.20
.426	5.94	5.28	5.13	5.65	4.51	5.81	5.19
.437	6.10	5.17	5.14	5.71	5.61	5.82	5.39
.447	5.97	4.98	5.07	—	5.64	5.83	5.36
30 052.462	6.52	5.83	5.23	5.53	5.92	6.13	5.79
.474	6.00	5.85	5.26	5.88	5.83	6.14	5.92
.489	5.60	5.87	5.14	5.65	5.99	6.35	5.71
.501	5.48	5.71	5.16	5.59	5.87	6.06	5.97
30 078.418	6.01	5.88	5.41	5.17	5.32	5.79	5.72
.434	5.94	5.79	5.05	5.30	5.39	5.81	5.71
.470	5.97	5.52	4.38	5.49	5.59	5.91	5.64
.483	6.08	5.25	4.44	5.39	5.50	5.94	5.76
.498	5.98	5.03	4.54	5.36	5.64	6.11	5.78
.509	6.20	4.95	4.73	5.66	5.74	5.95	5.77
.521	6.09	5.02	4.78	5.68	5.85	6.05	5.91
.536	5.73	4.98	4.79	5.50	5.98	6.08	5.89
.548	5.49	4.90	4.97	5.69	5.75	6.16	5.84
33 390.497	5.84	5.92	5.33	5.49	5.38	5.98	6.07
.534	5.65	5.40	5.37	5.79	5.59	6.00	5.74
.545	5.80	5.25	5.29	5.61	5.64	6.02	5.69
.558	5.79	4.99	5.35	5.52	5.55	6.07	5.59
.570	5.87	5.07	5.36	5.76	5.69	6.03	5.69
.586	5.97	5.15	5.44	5.88	5.81	6.15	5.48
33 420.424	6.03	5.52	6.15	5.00	5.40	5.63	5.34
.438	5.95	5.93	5.73	4.75	5.49	5.61	5.61
.450	5.58	5.80	5.62	4.59	5.60	5.58	5.50
.476	5.26	5.96	5.26	4.63	5.59	5.37	5.48
.487	5.19	5.93	5.07	4.80	5.48	5.48	5.74
.498	5.07	5.77	4.69	4.79	5.55	5.43	5.66
.510	5.16	5.90	4.64	4.94	5.81	5.57	5.85
.523	5.25	5.76	4.46	4.81	5.74	5.40	5.86

Table 9 (continued)

J. D. 2 400 000 +	27	28	31	32	33	34	35
33 421.385	5.92	5.50	5.62	5.62	4.82	5.92	5.36
.442	6.19	5.73	5.64	4.60	5.16	6.00	5.21
.454	6.00	5.77	5.49	4.53	5.17	5.88	5.37
.465	6.07	5.76	5.38	4.60	5.10	6.03	5.34
.475	6.08	5.84	5.37	4.62	5.20	6.01	5.29
.486	6.00	5.99	5.05	4.66	5.36	6.02	5.45
.497	6.04	5.96	5.35	4.81	5.35	5.77	5.53
.535	6.12	6.12	5.66	5.27	5.74	5.65	5.63
.548	6.03	5.88	5.53	5.18	5.70	5.44	5.82
33 422.398	5.79	5.79	5.36	5.46	5.92	6.18	6.09
.431	6.01	6.08	5.36	4.77	4.90	6.03	5.93
.442	5.99	5.93	5.51	4.67	4.85	6.01	5.45
.452	5.95	5.92	5.40	4.51	4.86	6.23	5.26
.462	6.09	6.09	5.34	4.76	4.92	6.02	5.10
.472	5.91	6.15	5.42	4.88	5.12	6.02	5.15
.483	6.27	5.90	5.49	4.85	5.02	6.27	5.02
.493	5.92	5.76	5.51	4.99	5.21	6.20	5.14
.508	5.85	5.80	5.30	4.95	5.19	6.08	5.16
.520	6.12	5.86	5.50	5.06	5.19	5.86	5.33
33 763.406	5.48	5.12	5.63	5.23	5.48	5.82	5.92
.420	5.53	5.23	5.45	—	5.57	5.85	6.04
.442	5.70	5.33	5.72	5.52	5.60	5.90	5.95
.455	5.77	5.39	5.71	5.71	5.75	5.98	6.07
.464	5.80	5.55	5.71	5.87	5.71	6.05	6.18
.483	5.78	5.55	5.58	5.62	5.71	6.05	6.19
.494	5.81	5.55	5.62	5.59	5.68	5.94	6.24
.504	5.87	5.76	5.50	5.59	5.83	6.08	6.00
.514	5.88	5.68	5.57	5.95	5.85	6.12	6.16
.525	5.96	5.72	5.51	—	5.84	6.02	6.07
34 118.355	5.37	—	—	—	—	5.72	5.76
.372	5.68	—	—	—	—	5.66	5.66
.388	5.36	5.93	—	—	4.92	5.59	5.56
.428	5.69	6.02	5.08	4.66	5.15	5.85	5.55
.443	5.88	5.80	5.43	4.85	5.49	5.97	5.49
.470	5.90	—	5.76	5.03	—	—	5.32
.485	5.81	5.69	5.32	5.13	5.59	5.92	5.59
.499	5.87	5.82	5.06	5.33	5.49	6.16	5.55
.513	5.84	5.67	4.76	5.11	5.43	6.23	5.60
.526	—	5.62	4.41	5.34	5.60	—	5.65
.540	6.09	5.80	4.34	5.55	5.66	6.09	5.68
34 120.471	5.95	5.18	5.14	5.34	4.96	5.06	—
.484	6.10	4.89	—	—	5.12	5.21	5.81
.497	6.14	4.83	5.26	5.22	5.07	5.23	5.80
.510	6.14	4.91	5.29	5.42	5.35	5.35	5.59
.523	6.09	4.85	5.33	5.36	5.36	5.36	5.49
.536	6.00	4.94	5.19	5.24	5.39	5.33	5.54

Table 9 (continued)

J. D. 2 400 000 +	27	28	31	32	33	34	35
34 120.551	5.87	4.89	5.46	5.46	5.43	5.50	5.47
.564	5.61	4.97	5.18	—	5.55	5.69	5.61
.579	5.22	5.04	—	—	5.66	5.55	5.55
34 121.401	5.93	5.60	5.20	4.81	5.84	6.02	5.95
.412	5.95	5.50	5.00	5.09	5.84	6.28	5.98
.422	5.95	5.32	4.78	5.08	5.86	6.12	6.04
.431	5.92	5.16	4.64	5.03	5.86	6.22	5.86
.441	5.88	4.83	4.53	5.14	5.65	6.43	5.97
.484	6.02	4.95	4.61	5.59	4.79	6.16	5.89
.495	5.96	4.98	4.60	5.40	4.77	6.00	6.05
.505	5.97	5.18	4.77	5.35	4.93	5.97	5.97
.517	6.06	5.21	4.77	5.65	5.05	5.86	6.04
.528	5.95	5.18	4.77	5.57	5.04	5.69	5.89
.539	6.02	5.35	—	—	5.16	5.70	5.89
.552	6.03	5.34	—	—	5.06	5.19	5.70
.562	—	5.37	—	—	5.19	5.09	5.67
.594	—	5.33	—	—	5.19	5.06	5.49
.605	—	—	—	—	—	5.14	5.46
34 122.404	5.40	—	—	—	5.77	—	5.88
.416	5.33	4.92	5.36	5.00	5.74	5.94	6.15
.431	5.52	5.00	5.35	5.16	5.93	6.08	5.88
34 126.433	5.28	5.88	5.47	5.22	5.80	6.08	5.58
34 131.415	5.98	5.49	4.86	5.41	5.68	6.08	5.98
34 487.347	5.78	5.76	4.77	5.94	5.90	5.90	5.36
.367	5.92	5.80	4.94	5.57	5.91	6.08	5.36
.385	6.06	5.44	5.02	5.89	5.91	5.91	5.50
.397	5.94	5.86	5.04	5.59	5.66	6.02	5.40
.410	6.14	6.00	5.22	5.38	6.18	6.12	5.62
.428	5.86	—	—	4.83	—	5.93	5.72
.438	5.93	5.82	5.12	4.80	5.82	6.19	5.64
.449	6.12	5.85	5.27	4.79	6.00	6.12	5.85
.460	6.16	5.97	5.27	4.72	5.87	5.91	5.83
.474	—	5.76	5.25	4.93	5.64	5.70	5.81
.483	5.98	6.01	5.22	4.90	5.59	5.86	5.87
.494	6.00	5.84	5.30	4.95	5.73	—	5.84
.508	6.06	—	5.30	4.97	5.45	6.18	6.06
.518	5.94	6.02	5.39	5.04	5.43	5.92	5.97
34 488.530	5.89	5.35	4.82	—	5.75	6.09	5.91
.540	5.80	5.11	4.88	5.44	5.71	5.92	5.82
34 567.388	5.96	5.89	5.54	5.70	5.20	5.85	5.43
35 223.415	5.82	5.65	5.43	5.51	5.23	5.95	5.90
.428	5.90	5.72	5.20	5.40	5.32	6.02	6.07
.441	6.00	5.81	5.63	5.50	5.28	6.07	5.94
.467	5.84	5.71	5.32	5.53	5.32	6.10	6.02
.490	6.02	5.94	5.43	5.49	5.57	6.04	5.96
.503	6.02	5.78	5.37	5.02	5.54	6.24	5.95

Table 9 (continued)

J. D. 2 400 000 +	27	28	31	32	33	34	35
35 223.517	6.06	5.83	5.29	4.63	5.55	6.08	6.06
.530	6.07	5.75	5.38	4.52	5.53	6.32	5.93
.546	6.11	5.79	5.42	4.68	5.51	6.05	5.91
.573	5.87	5.83	5.55	4.88	5.65	5.50	6.05
35 224.454	5.60	5.88	5.19	5.56	5.26	6.02	5.81
.472	5.57	5.66	5.30	5.57	5.18	6.11	5.75
.485	5.64	5.74	5.34	5.31	5.19	6.32	5.88
.499	5.87	5.84	5.38	4.93	5.36	6.12	5.89
.512	5.72	5.82	5.45	4.45	5.24	6.10	5.96
.524	5.72	5.72	5.33	4.56	5.26	6.14	5.72
.542	5.77	5.74	5.37	5.02	5.41	6.24	5.92
.556	5.81	5.53	5.39	4.85	5.34	6.08	5.88
.569	5.90	5.48	5.46	4.98	5.56	6.45	5.94
.583	5.84	5.27	5.59	—	5.54	6.00	6.06
35 227.534	6.09	5.40	5.40	4.87	6.12	5.26	5.40
.547	6.08	5.40	5.90	4.82	5.92	5.26	5.35
.560	6.06	5.78	5.54	5.11	5.78	5.36	5.60
.573	6.09	5.63	5.51	5.08	5.23	5.28	5.65
.586	6.32	5.71	5.55	5.48	5.34	5.37	5.58
35 598.507	5.44	5.76	5.86	4.48	5.30	5.80	5.88
.524	5.75	5.81	5.61	4.58	5.61	6.02	5.96
.537	5.90	5.88	5.58	4.60	5.39	6.18	5.82
35 600.363	5.88	5.97	5.82	5.52	5.72	6.12	5.74
.378	5.68	5.72	5.47	5.40	5.66	5.84	5.57
.391	5.93	5.76	5.49	5.58	6.07	5.95	5.67
.405	6.08	5.66	5.36	5.50	5.90	6.00	5.80
.421	6.08	5.75	5.62	5.64	5.93	5.86	5.50
.434	5.88	5.58	5.73	5.58	5.86	6.25	5.62
.446	6.07	5.87	5.64	5.62	5.80	6.25	5.59
.501	6.29	5.88	5.10	4.55	5.16	5.93	5.74
.525	6.03	5.88	4.50	4.88	5.10	5.02	5.88
35 603.369	6.03	5.78	—	—	5.72	5.01	6.08
.381	6.14	5.69	—	—	5.90	5.20	6.08
.397	5.95	5.49	5.26	5.66	5.66	5.24	5.84
.408	5.95	5.32	4.92	—	5.80	5.22	6.04
.419	6.03	5.33	4.66	5.60	5.85	5.52	6.06
.431	6.22	5.28	4.60	5.38	5.90	5.46	6.00
.446	6.02	5.19	4.74	4.73	5.82	5.45	5.96
.457	6.04	5.12	4.55	4.61	5.87	5.59	6.06
.468	6.00	4.93	4.59	4.76	5.83	5.67	6.01
.491	6.08	5.00	4.75	4.74	5.91	5.64	5.81
.507	6.12	5.04	4.74	4.88	5.80	5.86	5.94
35 920.444	5.07	5.38	5.95	6.00	5.13	5.03	5.64
.467	5.28	5.53	5.70	5.53	5.20	5.36	5.70
.487	5.23	5.86	5.08	4.29	5.36	5.62	5.72
.504	5.26	5.53	—	—	5.30	5.50	5.66

Table 9 (continued)

J. D. 2 400 000 +	27	28	31	32	33	34	35
35 920.547	5.49	5.56	4.87	5.20	5.48	5.56	5.94
.562	5.51	5.38	4.94	5.20	5.38	5.62	5.92
.585	5.60	5.05	5.05	5.60	5.30	5.60	6.18
35 933.415	5.82	4.72	5.22	5.12	5.77	5.91	6.04
.443	5.88	5.03	5.45	5.27	5.82	5.67	6.11
.479	5.95	5.22	5.33	5.50	4.62	5.93	5.95
.503	5.67	5.17	—	5.24	4.56	5.93	5.88
.515	5.80	5.29	—	5.50	4.48	5.85	5.95
.530	5.78	5.32	5.35	5.60	4.57	6.08	6.06
.543	—	—	—	—	4.57	5.96	5.63
.573	5.78	—	5.37	5.35	4.97	5.79	5.41
.588	—	—	—	5.59	5.00	5.65	5.42
.602	—	—	—	—	—	6.08	5.34
36 991.457	5.86	5.69	5.20	4.80	5.54	6.13	5.56
.470	6.19	6.09	5.36	5.09	5.96	6.11	5.53
.485	6.08	5.68	5.03	5.22	5.93	6.08	5.33
37 018.470	5.57	6.08	5.75	5.47	5.78	5.19	5.91
.483	5.82	5.84	5.46	5.69	5.92	5.28	5.98
.496	5.66	5.93	—	—	5.78	5.21	6.10
.510	5.70	6.09	5.80	5.31	5.95	5.29	6.04
.523	5.95	5.99	5.64	5.57	6.06	5.44	6.00
.537	5.67	—	5.21	5.89	5.88	5.40	5.88
.550	5.74	5.90	5.53	5.27	5.57	5.57	5.80
.563	5.91	6.08	5.36	—	5.56	5.62	5.98
.577	5.84	5.76	5.51	5.47	4.93	5.81	5.79
.609	6.05	5.31	5.48	5.51	4.86	5.84	5.44
.623	5.97	—	5.32	—	5.07	5.89	5.46
.637	6.08	5.58	4.88	—	5.24	5.92	5.55
37 057.539	6.05	6.20	4.73	—	5.34	5.31	6.01
.552	6.39	—	4.14	—	5.31	5.22	6.10
.578	6.09	—	4.41	—	5.69	5.28	6.09
37 058.529	6.05	6.12	5.78	—	4.78	6.05	5.85
.580	—	5.79	5.79	—	5.26	6.48	6.02
37 757.598	—	5.23	—	—	4.98	5.20	6.08
37 791.365	5.31	4.66	5.74	5.96	5.20	5.89	6.21
.380	5.18	4.34	5.91	—	5.46	5.93	5.93
.394	5.12	4.30	5.75	5.63	5.60	5.97	6.03
.424	5.25	4.31	5.59	4.95	5.54	6.02	5.86
.439	5.42	4.20	5.72	—	5.77	6.20	6.05
.454	5.15	4.54	5.53	5.11	5.57	5.99	6.32
.469	5.43	4.66	5.67	—	5.70	6.07	6.02
.483	5.24	4.95	5.47	5.06	5.86	6.13	6.09
.497	5.34	4.87	5.68	5.11	5.56	6.00	5.95
.519	5.53	5.10	5.87	5.45	5.90	6.19	5.90
.533	5.64	5.15	5.60	5.44	5.77	6.07	5.74
.549	5.66	5.24	5.57	5.25	5.92	6.16	5.60
.563	5.86	5.38	5.33	5.54	5.86	6.23	5.60

Table 9 (continued)

J. D. 2 400 000 +	36	37	38	39	40	41	42
28 963.487	6.07	5.49	6.22	5.84	5.30	5.75	5.34
28 991.403	6.02	5.89	6.07	6.10	6.23	5.69	5.78
.416	6.04	5.98	5.89	5.96	6.06	6.19	4.81
.430	5.78	5.99	5.99	6.00	6.37	6.06	4.30
.522	5.16	5.94	6.15	6.04	6.31	6.20	—
.542	4.82	5.54	5.92	6.08	6.45	6.31	4.60
29 346.376	5.77	5.57	6.24	5.39	5.69	5.79	5.09
.392	5.99	5.54	6.07	5.49	5.69	5.75	5.49
29 719.549	5.97	6.09	5.94	6.02	6.16	6.56	5.70
.560	5.95	6.04	5.93	6.14	6.14	6.20	5.55
29 720.546	5.57	6.02	5.67	6.04	6.38	6.22	5.15
.558	5.60	5.97	5.76	6.05	6.24	6.21	5.06
29 774.405	6.19	6.00	6.16	5.64	5.74	6.24	5.39
.417	5.85	6.06	6.06	5.64	5.88	6.65	5.24
29 775.403	6.16	5.98	5.98	5.98	5.21	6.20	5.05
.415	6.09	6.00	6.00	5.80	5.44	6.21	5.13
.426	6.04	6.04	5.97	5.74	5.19	6.39	5.16
.437	5.88	6.05	6.12	5.71	5.39	6.70	5.37
.447	6.08	5.92	6.00	5.56	5.60	6.65	5.33
30 052.462	6.10	5.79	5.66	6.29	6.03	6.57	5.71
.474	6.00	5.46	5.49	6.23	6.21	6.46	5.79
.489	6.09	5.57	5.22	6.30	6.07	6.30	5.57
.501	6.22	5.59	5.13	5.82	6.15	6.17	5.84
30 078.418	5.32	5.67	6.03	5.29	6.01	6.18	5.67
.434	5.44	5.76	5.98	5.27	6.08	6.04	5.49
.470	5.64	5.91	6.13	5.49	6.17	6.11	5.40
.483	5.62	6.00	6.02	5.55	6.39	6.39	5.58
.498	5.69	5.85	6.00	5.49	6.07	6.27	5.25
.509	5.69	6.11	6.22	5.66	6.09	6.19	4.85
.521	5.81	6.01	6.24	5.68	6.07	6.24	4.66
.536	5.89	6.04	6.18	5.63	6.22	6.10	4.29
.548	5.84	5.96	6.04	5.78	6.36	6.58	4.43
33 390.497	6.07	5.59	6.04	6.30	6.07	6.02	5.01
.534	6.27	5.76	5.90	6.27	6.12	6.15	4.35
.545	6.22	5.93	5.98	6.22	6.51	6.66	4.56
.558	6.22	5.81	5.74	6.20	6.24	5.98	4.61
.570	6.17	5.87	5.64	6.39	6.39	6.13	4.49
.586	5.55	6.05	5.53	6.24	6.24	—	4.94
33 420.424	6.23	5.66	6.00	6.23	6.55	5.89	5.92
.438	6.26	5.68	6.10	6.15	6.36	5.97	5.70
.450	6.18	5.50	6.16	6.19	6.16	5.97	5.70
.476	6.07	5.45	6.41	6.31	5.62	6.55	5.66
.487	6.05	5.68	6.18	6.11	5.36	6.30	5.59
.498	6.12	5.50	6.46	6.37	5.18	6.10	5.52
.510	6.22	5.45	6.34	6.14	5.19	6.39	6.05
.523	6.09	5.45	—	6.31	5.00	—	—

Table 9 (continued)

J. D. 2 400 000 +	36	37	38	39	40	41	42
33 421.385	5.89	5.76	5.43	5.89	6.14	5.90	5.31
.442	6.07	5.56	5.73	5.92	6.09	6.05	5.46
.454	6.00	5.47	5.77	5.99	6.30	6.28	5.62
.465	6.05	5.42	5.82	6.11	6.27	6.30	5.34
.475	6.10	5.52	5.90	6.10	6.13	6.01	5.37
.486	6.26	5.39	5.97	6.15	6.17	6.02	5.45
.497	6.21	5.37	6.04	6.15	6.13	6.32	5.37
.535	6.35	5.63	6.18	6.13	6.35	7.01	5.66
.548	6.20	5.63	5.98	6.10	6.20	—	5.60
33 422.398	5.74	5.57	5.03	5.27	5.99	6.18	4.67
.431	6.01	5.42	5.17	5.47	6.08	6.27	5.04
.442	5.76	5.54	5.32	5.63	6.25	6.25	4.70
.452	5.95	5.46	5.23	5.54	6.29	6.29	4.76
.462	5.81	5.35	5.22	5.60	6.53	6.15	4.89
.472	5.96	5.39	5.19	5.72	6.25	6.30	4.75
.483	6.27	5.46	5.54	5.78	6.29	6.42	4.75
.493	5.98	5.63	5.51	5.73	6.17	6.15	4.96
.508	6.11	5.51	5.41	5.74	6.34	6.36	4.90
.520	6.03	5.56	5.50	5.72	6.32	5.91	4.93
33 763.406	5.75	5.65	5.53	6.04	6.12	5.94	5.58
.420	5.72	5.48	5.50	5.99	6.13	6.14	5.82
.442	5.79	5.43	5.60	5.72	6.12	6.04	5.64
.455	5.94	5.41	5.69	5.55	6.21	6.40	5.66
.464	5.84	5.49	5.71	5.38	6.21	6.23	5.78
.483	5.98	5.44	5.71	5.23	6.30	6.45	5.06
.494	5.96	5.47	5.76	5.26	6.35	6.30	4.79
.504	6.12	5.50	5.72	5.27	6.21	6.02	4.52
.514	6.12	5.55	5.80	5.23	6.10	6.28	4.59
.525	6.05	5.56	5.77	5.30	5.70	6.61	4.79
34 118.355	6.36	6.01	5.76	6.12	5.82	—	—
.372	5.99	6.02	5.90	6.20	5.84	—	—
.388	6.24	5.99	5.84	6.20	5.84	—	—
.428	4.84	5.88	5.85	6.22	6.02	5.79	5.01
.443	4.88	5.68	5.98	6.06	6.04	5.90	5.43
.470	5.08	5.36	6.01	5.94	6.20	6.20	—
.485	5.10	5.36	6.02	5.92	6.16	6.34	5.59
.499	5.20	5.40	6.06	6.28	6.32	6.06	—
.513	5.30	5.43	6.21	6.18	6.18	6.23	5.73
.526	5.32	5.45	6.12	6.44	5.98	—	—
.540	5.51	5.51	5.95	6.17	6.37	6.42	5.40
34 120.471	6.23	5.36	5.22	5.53	5.36	6.16	—
.484	6.14	5.57	5.33	5.55	5.47	—	—
.497	6.09	5.45	5.41	5.73	5.54	—	—
.510	6.19	5.51	5.38	5.76	5.59	6.19	5.60
.523	6.07	5.52	5.55	5.82	5.67	6.02	5.06
.536	6.13	5.70	5.64	5.72	5.72	6.19	4.66

Table 9 (continued)

J. D. 2 400 000 +	36	37	38	39	40	41	42
34 120.551	6.27	5.75	5.62	5.75	5.80	6.36	4.40
.564	6.27	5.84	5.78	5.81	5.86	5.99	4.22
.579	5.86	5.88	5.96	5.98	5.96	6.12	4.46
34 121.401	5.93	5.48	6.05	5.95	6.31	6.00	—
.412	6.17	5.48	6.10	5.98	6.22	6.32	—
.422	5.95	5.40	6.24	6.14	6.16	6.14	—
.431	5.96	5.37	5.99	5.99	6.30	6.04	—
.441	6.06	5.35	6.14	6.10	6.22	6.10	—
.484	6.06	5.46	6.19	6.06	5.59	6.09	—
.495	6.10	5.58	6.05	6.05	5.40	6.17	—
.505	6.16	5.59	5.97	5.98	5.10	5.76	—
.517	6.12	5.68	6.06	5.94	5.14	6.12	—
.528	6.04	5.66	5.89	5.78	5.14	6.02	—
.539	6.08	5.70	5.82	5.61	5.19	—	—
.552	6.16	5.81	5.44	5.32	5.19	—	—
.562	6.01	5.70	5.30	5.30	5.24	—	—
.594	6.12	5.99	5.33	5.33	5.49	—	4.62
.605	—	6.00	5.27	5.30	5.47	—	—
34 122.404	5.80	5.42	—	6.01	—	—	—
.416	5.62	5.33	6.00	5.84	5.96	—	4.76
.431	5.71	5.29	6.00	5.98	6.15	6.10	4.87
34 126.433	6.13	—	5.94	5.78	5.84	5.82	4.84
34 131.415	6.60	—	6.10	6.10	5.52	5.41	—
34 487.347	5.47	5.65	5.97	5.20	5.90	5.44	5.62
.367	5.69	5.64	6.07	5.20	6.14	5.36	5.76
.385	5.79	5.71	5.91	5.22	5.96	5.30	5.99
.397	5.68	5.66	5.88	5.33	5.88	5.20	5.80
.410	—	5.92	5.92	5.38	5.92	5.32	5.76
.428	5.89	5.95	5.98	5.61	6.11	5.74	—
.438	5.82	5.93	5.93	5.46	6.11	5.25	5.78
.449	5.93	6.05	6.13	5.60	6.11	5.67	5.77
.460	6.06	5.97	6.02	5.66	6.40	5.73	5.89
.474	6.06	6.07	—	5.60	6.04	5.64	5.72
.483	5.83	6.01	6.06	5.74	6.08	5.54	5.70
.494	6.03	6.14	6.43	5.85	6.20	5.60	—
.508	6.00	5.94	6.08	6.12	6.17	5.57	5.47
.518	6.05	5.95	6.00	5.73	6.12	5.85	6.02
34 488.530	5.97	5.59	6.17	5.15	6.34	6.08	5.23
.540	5.82	5.54	5.88	5.06	6.01	5.85	5.59
34 567.388	6.12	5.70	6.10	5.89	6.19	5.29	4.86
35 223.415	5.74	5.93	6.07	6.18	6.18	5.95	5.23
.428	5.72	5.92	6.13	6.13	6.26	6.37	5.49
.441	5.81	5.89	6.10	6.00	6.15	6.19	5.50
.467	5.97	5.51	6.16	5.80	5.46	6.30	5.78
.490	6.01	5.43	5.92	5.62	5.02	6.30	5.51
.503	6.02	5.47	6.02	5.54	5.07	6.38	5.54

Table 9 (continued)

J. D. 2 400 000 +	36	37	38	39	40	41	42
35 223.517	5.96	5.41	6.07	5.60	5.14	6.14	5.01
.530	6.01	5.38	6.19	5.58	5.24	6.34	4.64
.546	6.08	5.38	6.03	5.51	5.36	6.08	4.33
.573	6.07	5.48	6.07	5.52	5.52	6.15	4.40
35 224.454	5.46	5.51	5.79	6.00	6.08	6.10	5.51
.472	5.50	5.45	6.06	6.16	6.32	6.09	5.38
.485	5.64	5.36	5.88	6.04	6.18	6.10	5.44
.499	5.62	5.41	6.04	6.26	6.26	6.01	5.60
.512	5.75	5.40	6.23	6.16	6.26	6.19	5.42
.524	5.82	5.33	5.96	6.06	6.49	6.30	5.52
.542	5.86	5.39	5.94	6.20	6.12	6.28	5.62
.556	5.95	5.53	5.88	6.03	5.81	6.12	5.88
.569	6.10	5.69	5.99	6.43	5.54	—	—
.583	5.99	5.78	6.26	6.00	5.15	6.06	5.59
35 227.534	6.45	—	6.04	5.96	5.83	5.46	5.91
.547	6.52	5.73	5.85	6.04	6.16	5.32	—
.560	—	5.80	5.80	6.06	5.95	5.14	5.95
.573	6.23	5.80	5.54	5.78	6.11	5.25	—
.586	5.71	5.71	5.40	5.71	5.79	5.32	—
35 598.507	6.04	5.32	6.02	6.11	5.58	6.44	5.47
.524	6.04	5.52	6.04	6.06	5.30	6.33	5.52
.537	6.00	5.54	5.98	6.22	5.09	6.00	5.60
35 600.363	5.69	5.82	5.54	5.64	6.03	6.09	5.50
.378	5.43	6.06	5.35	5.35	5.82	6.09	5.52
.391	5.78	5.87	5.34	5.50	5.93	6.08	5.46
.405	5.60	5.80	5.42	5.42	5.86	6.42	5.82
.421	5.62	5.64	5.60	5.52	6.08	6.02	5.75
.434	5.69	5.62	5.53	5.51	6.10	6.01	5.83
.446	5.87	5.39	5.64	5.52	6.07	6.25	5.70
.501	5.88	5.46	5.76	5.87	6.27	6.00	5.64
.525	6.16	5.70	5.97	5.92	6.30	5.45	5.70
35 603.369	6.02	5.48	5.86	5.44	6.22	—	—
.381	5.98	5.33	6.12	5.62	6.20	—	—
.397	6.10	5.34	5.94	5.73	6.05	6.08	5.73
.408	5.90	5.40	5.99	5.55	6.20	5.94	5.41
.419	6.04	5.45	6.10	5.69	6.36	5.98	5.69
.431	6.12	5.52	6.12	5.91	6.37	5.87	5.65
.446	6.13	5.47	6.02	5.60	6.08	5.53	5.67
.457	6.25	5.61	6.25	5.94	6.31	5.23	5.31
.468	6.09	5.49	6.14	5.76	5.62	5.14	5.70
.491	5.91	5.64	6.08	5.81	5.17	5.08	5.55
.507	5.24	5.77	6.12	6.02	5.08	5.38	5.80
35 920.444	6.16	6.00	6.17	5.08	6.29	6.32	5.39
.467	6.11	6.00	6.11	5.28	6.38	6.42	5.50
.487	5.90	—	5.87	5.22	5.91	5.84	4.63
.504	4.94	5.73	5.97	5.47	6.09	6.22	—

Table 9 (continued)

J. D. 2 400 000 +	36	37	38	39	40	41	42
35 920.547	4.87	5.49	6.13	5.70	6.29	6.32	4.83
.562	4.86	5.38	6.32	5.73	6.32	6.25	—
.585	5.08	5.74	6.14	5.87	6.22	6.30	4.40
35 933.415	5.77	5.69	6.19	5.52	5.52	5.77	5.69
.443	6.04	5.81	5.91	5.65	5.71	5.88	5.51
.479	5.93	5.95	5.15	5.72	5.72	5.95	4.71
.503	6.19	6.00	4.89	5.88	5.90	5.90	4.31
.515	6.03	6.22	5.04	5.85	5.99	5.99	4.30
.530	6.56	6.08	5.08	5.98	5.98	6.06	4.43
.543	—	6.07	5.19	5.98	5.89	6.10	4.29
.573	5.78	5.85	5.58	6.05	6.26	6.14	4.64
.588	5.18	5.56	5.74	5.96	6.01	5.88	4.48
.602	4.70	5.61	5.71	6.20	6.10	—	—
36 991.457	5.92	5.74	4.91	5.97	6.26	6.00	5.72
.470	6.19	6.06	4.74	6.16	6.14	6.14	—
.485	5.56	5.87	4.92	6.04	5.97	6.07	5.69
37 018.470	6.08	5.62	5.85	6.26	6.05	5.34	5.03
.483	6.20	5.67	5.88	6.21	6.12	5.45	5.12
.496	6.10	5.69	5.85	6.16	6.20	5.70	5.24
.510	5.97	5.87	5.98	6.05	6.12	5.74	5.12
.523	6.12	5.86	5.96	6.14	6.30	5.80	6.06
.537	5.92	5.90	5.92	5.90	5.90	5.66	—
.550	6.20	6.05	6.11	6.11	6.20	5.92	5.24
.563	6.08	6.12	6.41	—	6.30	5.89	—
.577	—	5.82	6.09	6.14	6.10	5.88	5.72
.609	6.22	6.05	5.96	6.24	6.40	6.05	5.48
.623	—	—	5.97	6.09	6.40	6.09	—
.637	6.35	5.98	6.11	6.32	6.03	6.52	5.58
37 057.539	4.94	5.69	6.05	5.72	5.95	6.19	—
.552	5.14	5.65	6.13	5.43	6.04	6.36	6.10
.578	5.28	5.50	—	5.28	6.36	6.12	—
37 058.529	6.29	5.60	5.73	6.16	5.35	6.29	5.56
.580	6.06	5.59	6.06	6.48	5.97	5.97	—
37 757.598	5.33	5.36	5.96	6.07	—	5.90	—
37 791.365	4.65	5.92	6.00	5.49	6.35	6.00	4.75
.380	5.02	5.93	5.93	5.40	6.23	5.89	4.89
.394	5.21	6.09	5.94	5.50	6.25	6.07	5.12
.424	5.31	6.09	6.03	5.43	5.85	6.36	5.27
.439	5.46	5.98	5.97	5.50	5.55	5.77	5.42
.454	5.31	6.03	5.95	5.47	5.36	—	—
.469	5.59	5.97	5.96	5.69	5.16	5.96	5.41
.483	5.47	5.86	6.06	—	5.12	5.86	5.24
.497	5.51	5.60	6.00	5.67	5.13	5.88	5.42
.519	5.85	5.53	6.16	5.77	5.32	5.66	5.27
.533	5.77	5.47	6.18	5.77	5.47	5.88	5.26
.549	6.01	5.44	6.06	5.77	5.60	5.66	5.30
.563	5.89	5.36	6.23	5.92	5.76	5.67	5.36

Table 9 (continued)

J. D. 2 400 000 +	43	44	54	46	47	48	49
28 963.487	4.70	5.87	5.42	5.22	5.57	5.60	5.93
28 991.403	5.38	6.04	5.35	5.72	4.74	5.48	6.01
.416	5.46	6.06	5.30	5.86	4.73	5.75	5.96
.430	5.33	5.96	5.33	5.94	4.65	5.47	5.91
.522	4.35	5.70	5.72	—	5.02	5.60	5.25
.542	4.23	5.58	5.73	5.82	5.09	5.45	5.32
29 346.376	5.33	5.97	5.35	5.57	5.11	5.74	5.24
.392	5.75	6.10	5.49	5.79	5.36	5.95	5.69
29 719.549	5.76	6.16	5.67	5.97	5.76	5.53	6.02
.560	5.66	6.60	5.55	5.77	5.77	5.66	5.77
29 720.546	5.62	5.89	5.18	5.87	5.98	5.96	5.98
.558	5.57	5.90	4.80	5.69	5.85	5.76	5.88
29 774.405	5.55	6.16	6.00	5.49	5.41	5.84	5.34
.417	5.60	5.98	5.88	5.54	5.39	6.06	5.06
29 775.403	5.46	6.04	5.56	6.08	5.26	5.48	6.10
.415	5.49	6.02	5.70	5.94	5.23	5.36	6.02
.426	5.55	5.97	5.59	5.81	5.33	5.53	6.04
.437	5.57	5.64	5.90	6.19	5.39	5.57	6.02
.447	5.50	5.53	5.92	6.00	5.50	5.58	6.04
30 052.462	5.90	5.17	5.83	5.80	5.55	5.79	5.66
.474	5.88	5.06	5.88	5.79	5.49	5.83	5.60
.489	5.65	5.14	5.87	5.75	5.56	5.87	5.62
.501	5.64	5.23	5.91	5.85	5.69	5.91	5.91
30 078.418	5.96	5.56	6.20	5.99	5.59	5.96	5.99
.434	5.76	5.49	6.30	5.94	5.57	5.94	5.88
.470	5.24	5.62	6.09	5.75	5.64	5.83	—
.483	4.69	5.57	6.10	5.72	5.65	5.62	5.96
.498	4.40	5.58	5.92	5.66	5.66	5.49	5.90
.509	4.53	5.71	6.19	5.69	5.77	5.41	5.88
.521	4.69	5.89	6.09	5.53	5.91	5.45	5.97
.536	4.86	5.83	6.32	5.45	5.84	5.36	6.00
.548	4.86	5.78	6.20	5.32	5.94	5.31	6.07
33 390.497	5.69	6.07	6.47	6.14	5.94	5.84	5.05
.534	5.68	6.03	6.12	5.92	5.95	5.83	5.33
.545	5.67	6.02	6.22	6.02	6.00	5.82	5.33
.558	5.57	5.95	6.47	6.07	5.91	5.74	5.38
.570	5.80	5.96	6.17	5.87	5.87	5.78	5.52
.586	5.55	5.97	6.37	5.97	5.97	5.84	5.63
33 420.424	5.34	6.00	5.60	5.66	5.98	5.19	6.41
.438	5.21	6.07	5.68	5.95	5.90	5.40	6.24
.450	5.33	5.98	5.86	5.87	5.87	5.41	5.95
.476	5.26	5.93	5.98	5.80	5.16	5.34	6.09
.487	5.48	6.05	5.90	5.90	4.93	5.41	6.05
.498	5.56	5.94	6.18	6.00	4.79	5.35	6.14
.510	5.38	5.92	6.03	6.08	4.84	5.30	6.03
.523	5.34	5.49	—	6.02	4.98	5.49	6.09

Table 9 (continued)

J. D. 2 400 000 +	43	44	45	46	47	48	49
33 421.385	5.50	6.00	5.07	5.58	5.92	5.76	5.90
.442	5.33	5.90	5.40	5.39	6.09	5.92	6.04
.454	5.20	5.84	5.51	5.34	5.95	5.80	6.15
.465	5.06	6.05	5.54	5.27	5.90	5.80	6.25
.475	5.05	5.83	5.71	5.29	6.10	5.80	6.10
.486	4.97	5.99	5.78	5.41	6.03	5.89	6.22
.497	5.17	5.96	5.62	5.43	6.17	5.70	6.07
.535	5.16	5.70	5.90	5.72	5.79	5.98	6.35
.548	5.31	5.58	5.86	5.66	5.39	5.96	6.12
33 422.398	5.79	6.24	6.07	6.07	5.99	5.57	5.94
.431	6.03	6.18	5.07	5.99	6.08	5.62	5.93
.442	5.83	6.08	5.18	5.76	5.76	5.67	6.03
.452	5.76	5.99	4.96	5.95	5.95	5.64	5.70
.462	5.60	5.89	5.04	5.89	5.83	5.50	6.02
.472	5.57	5.77	5.24	5.91	6.06	5.57	6.00
.483	5.57	6.09	5.29	5.92	6.01	5.87	6.27
.493	5.63	6.13	5.30	5.76	5.92	5.76	5.92
.508	5.39	6.06	5.33	5.94	6.03	5.66	5.97
.520	5.30	5.72	5.78	5.86	5.86	5.59	6.00
33 763.406	5.92	5.43	5.26	5.92	5.75	5.65	5.72
.420	5.75	5.38	5.35	5.94	5.63	5.60	5.80
.442	5.82	5.45	5.50	6.02	5.35	5.73	5.81
.455	5.98	5.62	5.55	5.98	5.27	5.77	5.89
.464	5.91	5.55	5.58	5.95	5.24	5.67	5.89
.483	5.98	5.53	5.50	5.87	5.23	5.82	5.85
.494	5.81	5.61	5.66	5.94	5.21	5.70	5.88
.504	6.00	5.61	5.67	5.97	5.35	5.79	5.93
.514	6.02	5.65	5.85	5.90	5.44	5.73	5.95
.525	6.05	5.65	5.82	5.98	5.45	5.82	5.98
34 118.355	5.82	5.68	5.37	5.74	5.37	5.89	6.08
.372	5.66	5.23	5.50	5.50	5.26	5.60	5.79
.388	5.84	5.04	5.50	5.59	5.28	5.87	6.16
.428	5.61	5.19	5.85	5.82	5.41	5.85	5.72
.443	5.86	5.46	5.88	5.74	5.57	5.78	5.83
.470	5.94	5.68	6.18	5.87	5.66	5.60	5.36
.485	5.78	5.55	6.16	5.71	5.55	5.44	5.10
.499	5.82	5.55	6.09	5.90	5.55	5.42	5.09
.513	5.84	5.76	6.23	5.76	5.46	5.27	5.16
.526	—	5.75	5.84	5.72	—	5.37	5.22
.540	5.48	5.77	6.30	5.99	5.77	5.30	5.33
34 120.471	5.18	5.36	5.31	5.79	5.45	5.31	5.95
.484	5.21	5.52	5.40	5.81	5.40	5.49	5.98
.497	5.60	5.45	5.60	5.96	5.32	5.41	6.01
.510	5.45	5.55	5.55	5.85	5.40	5.40	5.96
.523	5.44	5.67	5.59	5.69	5.49	5.39	5.94
.536	5.62	5.62	5.72	5.88	5.36	5.41	5.90

Table 9 (continued)

J. D. 2 400 000 +	43	44	45	46	47	48	49
34 120.551	5.66	5.77	5.75	5.91	5.35	5.47	6.15
.564	5.73	5.86	5.90	5.95	5.50	5.50	5.98
.579	5.52	5.88	5.88	6.00	5.61	5.63	6.00
34 121.401	4.78	5.48	6.20	5.58	5.78	5.82	5.62
.412	4.70	5.42	—	5.66	5.93	5.84	5.76
.422	4.84	5.27	6.38	5.69	5.69	5.82	5.82
.431	4.85	5.42	6.12	5.70	5.74	5.81	5.76
.441	4.87	5.32	6.00	5.74	5.70	5.79	5.92
.484	5.20	5.46	4.87	5.68	5.78	5.80	5.93
.495	5.22	5.64	4.89	5.70	5.83	5.83	6.03
.505	5.39	5.59	5.06	5.73	5.67	5.80	5.96
.517	5.51	5.51	5.18	5.80	5.71	5.92	6.02
.528	5.69	5.69	5.22	5.74	5.66	5.83	5.89
.539	5.66	5.66	5.32	5.75	5.48	5.76	6.02
.552	5.70	5.70	5.39	5.87	5.44	5.87	5.98
.562	—	—	5.32	5.84	5.37	—	—
.594	5.66	5.66	5.53	5.71	5.36	5.69	5.99
.605	—	—	5.73	—	5.35	5.67	—
34 122.404	5.54	5.54	6.08	5.77	5.69	5.42	5.54
.416	5.29	5.29	6.32	5.74	5.65	5.38	5.40
.431	5.27	5.27	6.28	5.91	5.80	5.54	5.50
34 126.433	5.78	5.78	5.74	5.58	5.42	5.66	5.89
34 131.415	6.22	6.22	6.04	5.85	5.47	5.98	5.90
34 487.347	4.92	6.08	5.88	5.92	5.41	5.80	5.97
.367	5.18	6.00	5.92	5.96	5.38	5.86	6.18
.385	5.26	6.24	6.14	6.12	5.26	5.84	6.14
.397	5.17	6.14	5.70	5.84	5.17	5.61	5.72
.410	5.24	6.42	6.26	5.84	5.40	6.09	5.60
.428	5.36	5.92	6.12	5.56	5.36	5.89	4.73
.438	5.33	6.14	5.93	5.46	5.42	5.84	4.79
.449	5.63	5.60	6.23	5.56	5.60	5.90	4.85
.460	5.37	5.54	6.33	5.52	5.52	5.66	4.86
.474	5.36	5.64	6.35	5.33	5.48	5.70	4.90
.483	5.54	5.80	—	5.37	5.70	5.76	5.02
.494	5.26	5.57	—	5.23	5.53	5.73	5.19
.508	5.84	5.39	6.20	5.47	5.64	5.62	5.32
.518	5.91	4.95	6.10	5.41	5.63	6.05	5.53
34 488.530	5.63	4.88	6.21	5.87	5.42	5.81	4.68
.540	5.25	4.82	6.04	5.82	5.44	5.71	4.80
34 567.388	5.10	6.00	6.28	5.91	4.92	5.34	6.17
35 223.415	4.90	5.01	6.10	5.82	5.82	5.70	5.98
.428	5.00	5.09	6.26	5.92	5.92	5.62	5.92
.441	5.30	5.30	6.20	5.63	5.89	5.52	5.96
.467	5.14	5.42	6.14	5.55	5.84	5.24	5.99
.490	5.43	5.70	6.17	5.49	5.88	5.20	6.06
.503	5.30	5.65	6.27	5.54	5.89	5.25	6.02

Table 9 (continued)

J. D. 2 400 000 +	43	44	45	46	47	48	49
35 223.517	5.45	5.75	6.08	5.36	5.91	5.19	5.91
.530	5.34	5.77	6.28	5.36	5.75	5.24	5.94
.546	5.71	5.85	6.25	5.28	5.51	5.24	5.94
.573	—	6.07	—	5.40	4.77	5.32	5.97
35 224.454	4.79	5.19	5.88	5.68	5.98	5.83	5.74
.472	4.80	5.30	6.01	5.78	5.86	5.70	5.70
.485	5.00	5.44	6.08	5.90	5.92	5.85	5.99
.499	5.10	5.50	6.08	5.94	5.99	5.80	6.06
.512	5.08	5.60	6.23	5.94	5.98	5.75	5.94
.524	5.02	5.62	5.98	5.90	5.88	5.79	5.88
.542	5.50	5.79	6.03	5.90	5.83	5.77	5.92
.556	5.51	5.83	6.14	6.03	5.86	5.83	6.05
.569	5.42	6.07	6.20	5.79	5.90	5.82	5.94
.583	5.59	6.12	6.31	5.92	6.06	5.84	6.10
35 227.534	6.14	5.83	5.26	6.09	5.88	6.00	5.43
.547	6.24	5.64	5.30	5.98	6.08	5.92	5.40
.560	6.06	5.78	5.40	5.97	6.00	6.24	5.57
.573	—	5.91	5.54	5.94	6.13	5.92	5.58
.586	6.10	5.58	5.58	6.03	5.76	6.03	5.68
35 598.507	5.40	6.13	5.20	5.74	5.30	5.68	6.02
.524	5.54	6.04	5.48	5.88	5.52	5.81	6.17
.537	5.40	6.02	5.34	5.96	5.52	5.66	6.36
35 600.363	5.82	6.05	6.30	5.82	6.03	5.69	5.19
.378	5.75	6.27	5.98	5.74	5.96	5.55	5.16
.391	5.89	6.13	6.16	5.93	5.97	5.69	5.46
.405	5.82	6.16	6.30	5.84	5.84	5.71	5.42
.421	5.73	6.02	6.12	5.73	5.88	5.88	5.53
.434	5.58	6.08	6.21	5.79	5.64	5.83	5.69
.446	5.74	6.00	6.27	5.74	5.80	5.87	5.59
.501	5.18	6.12	6.27	5.93	5.90	6.02	5.80
.525	4.72	6.16	—	6.05	5.75	6.12	5.92
35 603.369	5.37	5.92	5.22	5.66	5.32	5.23	5.94
.381	5.55	5.94	5.41	5.78	5.44	5.37	6.16
.397	5.57	6.01	5.50	5.66	5.37	5.40	6.16
.408	5.20	5.84	5.41	5.54	5.30	5.32	6.02
.419	5.52	6.14	5.56	5.80	5.45	5.58	6.14
.431	5.74	6.00	5.72	5.96	5.46	5.60	5.90
.446	5.66	6.02	5.70	5.84	5.58	5.55	6.13
.457	5.68	6.15	5.95	5.89	5.50	5.52	5.98
.468	5.76	6.25	5.70	5.95	5.46	5.46	6.11
.491	5.60	6.00	6.00	5.78	5.66	5.58	6.02
.507	5.64	6.12	6.08	5.96	5.68	5.54	6.02
35 920.444	—	5.85	6.22	5.39	4.71	5.14	4.91
.467	—	6.00	6.11	5.60	5.07	5.32	4.74
.487	—	5.92	5.99	5.36	5.00	5.42	4.74
.504	—	5.99	6.03	5.42	5.08	5.30	4.94

Table 9 (continued)

J. D. 2 400 000 +	43	44	45	46	47	48	49
35 920.547	—	6.13	6.20	5.33	5.20	5.60	5.37
.562	—	6.00	5.95	5.38	5.20	—	5.20
.585	—	5.89	5.60	5.43	5.17	—	5.26
35 933.415	—	5.24	6.47	5.52	5.18	5.69	5.80
.443	—	5.24	6.08	—	5.25	5.86	5.99
.479	—	5.50	5.67	5.74	5.22	5.67	5.84
.503	—	5.56	4.87	5.69	5.27	5.19	5.80
.515	—	5.80	4.92	5.65	5.52	5.21	5.91
.530	—	5.69	5.02	5.55	5.24	5.24	6.08
.543	—	5.79	5.16	—	5.06	4.85	5.96
.573	—	5.67	5.58	5.64	5.41	4.93	5.81
.588	—	5.74	5.36	5.48	5.34	5.10	5.42
.602	—	5.51	5.51	—	5.03	5.08	5.21
36 991.457	5.40	5.98	6.26	5.90	5.92	5.14	5.84
.470	5.80	6.16	6.09	5.87	5.82	5.21	5.96
.485	5.88	6.16	6.32	5.87	5.93	5.37	6.19
37 018.470	5.55	5.01	6.18	5.69	5.84	5.31	—
.483	5.45	4.84	6.14	5.78	6.16	5.46	6.20
.496	5.63	4.95	6.27	5.69	5.79	—	5.98
.510	5.85	5.09	6.19	5.95	6.02	5.38	5.50
.523	5.80	5.16	6.12	5.96	6.20	5.54	4.95
.537	5.55	5.15	5.85	5.76	5.86	—	4.88
.550	—	5.37	5.30	5.86	5.69	5.57	4.80
.563	5.69	5.46	5.06	5.94	5.36	—	4.94
.577	5.88	5.53	4.96	5.87	4.93	5.70	5.06
.609	5.84	5.74	5.24	5.97	4.94	5.84	5.20
.623	5.70	5.94	5.43	6.09	4.98	5.63	5.55
.637	—	5.96	5.34	6.22	5.48	5.77	5.58
37 057.539	5.69	5.20	6.15	5.43	5.38	5.69	5.31
.552	5.87	5.27	6.24	5.38	5.05	5.75	5.38
.578	6.20	5.34	6.12	5.66	5.39	5.89	5.55
37 058.529	5.78	5.35	6.05	5.89	5.89	5.73	5.45
.580	—	5.53	6.36	—	6.48	—	5.20
37 757.598	4.59	5.92	6.01	5.58	5.26	5.52	5.52
37 791.365	—	5.74	6.03	5.69	5.49	5.46	5.85
.380	5.72	5.85	5.93	5.61	5.40	5.52	5.93
.394	5.51	5.86	5.98	5.73	5.73	5.51	5.82
.424	5.39	5.95	5.99	5.57	5.47	5.47	5.83
.439	5.72	5.97	6.12	5.82	5.74	5.63	5.96
.454	5.64	5.95	6.32	5.64	5.72	5.44	5.81
.469	5.56	5.82	6.07	5.66	5.86	5.62	5.72
.483	5.40	5.90	6.20	5.86	5.81	5.56	5.56
.497	5.42	5.85	6.26	5.66	5.73	5.64	5.49
.519	5.81	5.85	6.14	5.90	5.96	5.87	5.45
.533	—	5.88	6.38	5.82	5.82	5.74	5.26
.549	5.46	5.77	6.12	5.86	5.90	5.81	5.40
.563	5.23	5.73	6.39	5.95	5.98	5.76	5.43

Table 9 (continued)

J. D. 2 400 000 +	50	51	52	53	54	55	56
28 963.487	5.35	5.30	5.96	4.97	5.60	6.34	5.84
28 991.403	6.04	6.12	5.83	5.35	5.72	5.83	5.48
.416	6.02	5.91	5.91	5.21	5.18	5.84	5.28
.430	6.00	6.09	5.91	5.33	5.13	5.99	5.47
.522	6.25	5.16	5.02	5.30	4.80	6.25	6.03
.542	6.26	5.10	5.20	5.39	4.75	6.24	5.92
29 346.376	5.42	6.06	5.95	5.30	4.99	5.97	5.42
.392	5.71	6.20	5.95	5.49	4.95	5.73	5.36
29 719.549	6.09	6.21	5.90	5.60	5.00	6.11	5.78
.560	6.16	6.14	6.00	5.55	4.98	6.18	5.82
29 720.546	6.00	6.06	5.89	5.54	4.80	6.16	5.67
.558	6.07	6.13	5.85	5.44	4.97	6.21	5.80
29 774.405	5.86	6.28	6.03	5.12	5.71	5.61	6.30
.417	5.98	6.11	5.91	5.15	5.82	5.85	5.91
29 775.403	5.93	5.77	6.14	4.87	5.61	5.21	5.99
.415	6.02	5.91	5.97	5.10	5.76	5.29	6.04
.426	6.00	5.86	5.92	5.16	5.72	5.41	5.81
.437	6.02	5.95	5.93	5.26	5.88	5.44	5.69
.447	5.95	5.95	5.85	5.18	5.83	5.39	5.64
30 052.462	6.03	6.24	6.10	5.99	5.85	5.08	5.72
.474	6.04	6.22	6.27	5.67	5.92	4.97	5.67
.489	5.99	5.99	6.25	5.96	5.84	5.17	5.87
.501	6.15	6.15	6.24	5.80	5.97	5.18	5.69
30 078.418	5.49	5.69	6.14	5.38	5.86	5.06	5.49
.434	5.27	5.60	6.08	5.39	5.71	4.82	5.39
.470	5.27	5.75	6.19	5.54	5.59	5.32	5.73
.483	5.20	5.82	6.04	5.72	5.45	5.39	5.67
.498	5.38	5.83	5.70	5.88	5.15	5.49	5.76
.509	5.51	6.07	5.26	5.63	4.80	5.44	5.71
.521	5.53	5.93	5.09	5.70	4.88	5.62	5.91
.536	5.63	6.00	4.92	5.66	4.92	5.56	5.89
.548	5.46	6.00	5.00	5.82	4.94	5.66	5.84
33 390.497	5.57	6.11	5.98	5.53	5.90	6.07	5.40
.534	5.74	6.30	6.12	5.65	5.90	5.92	5.36
.545	5.69	6.22	6.02	5.54	5.98	6.22	5.42
.558	5.77	6.24	6.09	5.74	5.95	6.22	5.40
.570	5.80	6.17	6.17	5.64	5.80	6.17	5.40
.586	6.18	6.24	6.24	5.79	5.76	6.40	5.48
33 420.424	6.13	5.19	5.92	5.75	6.09	6.47	6.23
.438	6.24	5.37	6.00	5.93	5.83	6.70	6.12
.450	6.12	5.33	6.21	5.87	5.89	6.19	5.89
.476	6.18	5.42	6.09	5.87	5.91	5.45	5.74
.487	6.46	5.50	6.13	5.80	5.74	5.21	5.70
.498	6.55	5.43	5.96	5.73	—	5.10	5.33
.510	6.05	5.45	5.94	5.66	6.08	5.05	5.45
.523	—	5.56	5.94	—	—	4.94	5.42

Table 9 (continued)

J. D. 2 400 000 +	50	51	52	53	54	55	56
33 421.385	5.74	6.12	5.64	5.66	5.86	6.33	6.00
.442	6.15	6.15	6.02	5.90	5.70	6.09	5.87
.454	6.13	5.99	5.88	5.79	5.79	6.40	5.73
.465	6.09	6.23	5.92	5.80	5.60	6.30	5.48
.475	6.10	6.37	5.84	5.72	5.77	6.22	5.52
.486	6.26	6.47	5.99	5.76	—	6.34	5.44
.497	6.28	6.13	5.89	5.77	5.87	6.30	5.43
.535	6.12	6.08	6.12	5.74	—	5.44	5.50
.548	6.27	5.60	6.18	5.58	—	5.18	5.39
33 422.398	5.92	5.99	5.71	5.81	6.07	6.12	5.79
.431	5.95	6.11	5.93	5.91	6.05	6.44	5.83
.442	5.99	6.22	6.03	5.76	5.83	6.03	5.76
.452	6.16	6.23	5.95	5.76	5.99	6.20	5.58
.462	6.13	6.15	6.09	6.13	6.05	6.15	5.37
.472	5.91	6.15	5.91	5.80	5.93	6.15	5.42
.483	6.24	6.19	5.87	5.95	5.87	6.12	5.46
.493	6.21	6.21	5.90	5.73	5.90	6.33	5.47
.508	6.20	6.20	5.88	5.80	5.80	6.44	5.43
.520	6.18	6.05	5.81	5.72	5.83	6.29	5.33
33 763.406	5.18	5.84	5.93	5.80	4.75	5.61	5.65
.420	5.23	5.87	5.87	5.78	4.77	5.71	5.80
.442	5.47	5.90	5.96	5.12	4.90	5.81	5.79
.455	5.46	5.98	6.18	4.77	5.17	5.94	5.89
.464	5.62	6.01	6.18	4.72	5.14	5.93	5.95
.483	5.65	6.06	6.00	4.82	5.23	6.05	6.00
.494	5.75	6.09	5.55	4.90	5.26	5.94	5.94
.504	5.87	6.12	5.30	4.92	5.37	6.04	5.99
.514	5.85	6.14	4.99	5.02	5.39	6.14	6.04
.525	5.93	6.17	4.99	5.17	5.42	6.15	6.02
34 118.355	5.97	5.37	5.88	5.96	—	5.82	5.88
.372	6.04	5.41	5.84	5.20	—	5.66	5.75
.388	6.12	5.68	5.99	4.80	4.90	5.68	5.73
.428	5.02	5.85	6.08	4.72	4.72	5.88	5.99
.443	4.88	5.88	6.02	4.92	4.92	5.86	5.95
.470	4.82	5.87	6.10	5.27	—	6.25	6.26
.485	5.00	5.84	6.02	5.14	5.25	6.04	5.92
.499	5.13	5.90	6.06	5.33	5.23	6.32	5.99
.513	5.27	5.96	6.02	5.43	5.46	6.26	6.02
.526	5.29	5.80	6.02	5.45	—	5.98	5.80
.540	5.58	6.33	5.95	5.37	5.33	6.22	5.66
34 120.471	5.22	6.06	5.83	4.99	4.87	5.56	5.99
.484	4.95	6.19	5.87	5.24	5.03	5.62	6.00
.497	4.83	6.07	5.96	5.13	5.13	5.73	6.00
.510	4.86	6.12	5.96	5.29	5.19	5.73	5.76
.523	4.85	6.11	6.16	5.30	5.28	5.80	5.88
.536	4.98	6.20	6.09	5.36	5.24	5.84	5.54

Table 9 (continued)

J. D. 2 400 000 +	50	51	52	53	54	55	56
34 120.551	5.03	6.18	6.03	5.40	5.38	5.82	5.32
.564	5.25	5.88	6.07	5.66	5.50	5.95	5.61
.579	5.46	5.55	6.02	5.78	5.55	5.96	5.46
34 121.401	6.22	5.78	5.78	5.16	—	6.12	5.97
.412	6.14	5.86	5.66	4.94	5.37	5.91	6.17
.422	6.29	5.90	5.72	4.70	5.18	5.50	6.30
.431	5.96	5.88	5.76	4.64	4.85	5.21	5.96
.441	6.16	6.08	5.81	4.72	4.87	4.95	5.92
.484	5.82	6.09	5.93	5.04	4.91	5.20	6.02
.495	5.38	6.11	5.92	5.06	4.93	5.26	5.94
.505	5.17	6.04	5.96	5.21	5.21	5.39	5.85
.517	4.87	6.10	6.00	5.34	5.24	5.38	5.75
.528	4.82	5.94	5.89	5.22	5.30	5.46	5.54
.539	4.83	6.19	6.02	5.43	5.40	5.54	5.46
.552	4.83	6.24	6.02	5.32	5.39	5.63	5.44
.562	5.02	6.20	—	5.32	—	5.73	5.32
.594	5.30	6.01	6.01	5.53	5.60	5.84	5.42
.605	5.25	—	—	—	—	5.71	5.46
34 122.404	—	5.40	5.50	5.46	—	—	5.78
.416	6.42	5.38	5.45	5.05	—	6.15	6.20
.431	6.26	5.56	5.56	4.75	—	6.24	6.02
34 126.433	6.21	5.42	5.34	5.66	5.84	6.00	5.89
34 131.415	5.83	6.26	6.27	5.90	5.78	6.35	5.60
34 487.347	5.17	5.25	5.36	5.90	5.66	6.20	6.10
.367	5.43	5.23	5.40	5.76	—	6.12	5.64
.385	5.63	5.26	5.53	5.79	5.68	6.12	5.44
.397	5.57	5.33	5.40	5.72	—	5.94	5.40
.410	5.67	5.49	5.88	6.16	5.88	6.09	5.57
.428	5.63	5.63	5.63	5.72	5.81	6.02	5.40
.438	5.83	5.56	5.64	5.42	5.66	6.20	5.38
.449	5.83	5.60	5.77	5.16	5.67	6.12	5.39
.460	5.66	5.60	5.83	4.86	5.66	6.18	5.40
.474	5.82	5.55	5.60	4.69	6.19	6.09	5.40
.483	5.98	5.66	5.72	4.74	6.08	—	5.50
.494	6.07	5.78	5.78	4.79	—	6.18	5.50
.508	6.02	5.86	5.66	4.87	5.86	5.84	5.53
.518	6.00	5.91	5.92	4.98	5.60	5.60	5.59
34 488.530	6.02	5.05	5.95	5.00	—	6.35	5.81
.540	6.01	5.34	5.77	5.12	—	6.25	5.82
34 567.388	5.63	5.45	5.23	5.50	—	6.21	6.00
35 223.415	5.90	5.95	6.01	5.77	5.33	6.27	5.39
.428	5.84	6.13	5.77	5.77	5.27	5.79	5.32
.441	5.81	6.07	5.63	5.85	5.28	5.37	5.43
.467	5.84	6.19	5.02	5.78	5.17	4.98	5.30
.490	5.97	6.10	5.04	5.72	5.04	5.07	5.49
.503	5.95	6.13	5.21	5.79	4.91	5.25	5.62

Table 9 (continued)

J. D. 2 400 000 +	50	51	52	53	54	55	56
35 223.517	6.08	6.16	5.19	5.72	5.01	5.24	5.65
.530	6.17	6.19	5.34	5.82	5.04	5.45	5.70
.546	5.91	6.15	5.40	5.69	5.06	5.53	5.96
.573	5.89	5.87	5.32	5.05	5.40	5.78	6.05
35 224.454	5.68	5.79	5.76	5.72	5.12	6.21	5.46
.472	5.80	5.75	5.54	5.70	4.98	6.25	5.45
.485	5.88	5.70	5.26	5.72	5.02	6.06	5.54
.499	5.80	5.84	5.02	5.92	4.83	5.50	5.73
.512	5.78	5.80	4.98	5.80	4.95	5.08	5.72
.524	5.74	5.67	5.09	5.88	4.94	4.94	5.80
.542	5.88	5.98	5.19	5.85	5.00	5.00	5.94
.556	5.86	5.88	5.30	5.68	5.04	5.14	6.14
.569	6.14	6.03	5.36	5.54	5.26	5.20	6.12
.583	6.14	6.08	5.59	5.20	5.27	5.46	5.89
35 227.534	5.88	6.36	6.40	6.07	5.11	6.25	5.80
.547	5.80	6.14	6.14	6.16	5.15	6.12	6.00
.560	5.90	6.42	5.84	5.92	5.05	6.58	6.20
.573	5.74	5.82	5.51	6.12	—	6.04	5.94
.586	6.03	6.14	5.10	—	—	6.00	5.74
35 598.507	6.14	5.86	5.80	5.80	5.88	6.26	5.40
.524	6.44	6.14	6.02	6.02	5.98	6.04	5.36
.537	6.32	6.00	5.86	5.79	5.98	5.90	5.36
35 600.363	5.43	5.88	5.24	5.30	5.43	6.03	6.12
.378	5.38	5.40	5.06	5.38	5.35	6.29	5.92
.391	5.48	5.34	5.34	5.52	5.57	5.87	5.92
.405	5.78	5.16	5.29	5.50	5.68	6.05	5.77
.421	5.91	5.25	5.46	5.53	5.66	6.00	5.78
.434	5.64	5.21	5.27	5.53	5.56	6.57	5.51
.446	5.89	5.29	5.30	5.60	5.77	6.07	5.53
.501	5.97	5.59	5.66	5.85	5.85	6.29	5.28
.525	5.92	5.79	5.82	5.79	5.88	6.59	5.66
35 603.369	4.87	5.27	6.12	5.25	5.32	5.16	5.94
.381	4.97	5.44	6.04	5.37	—	5.22	5.86
.397	5.10	5.47	6.05	5.49	—	5.37	5.59
.408	5.07	5.50	5.95	5.50	—	5.41	5.52
.419	5.35	5.56	5.62	5.56	—	5.50	5.43
.431	5.40	5.82	5.60	5.54	—	5.58	5.52
.446	5.37	5.63	5.29	5.60	5.58	5.47	5.24
.457	5.62	5.80	5.32	5.56	5.57	5.82	5.40
.468	5.57	5.87	5.20	5.67	5.59	5.73	5.39
.491	5.71	5.82	5.32	5.62	5.71	5.81	5.42
.507	5.80	5.86	5.56	5.74	5.60	5.82	5.59
35 920.444	4.95	5.04	4.71	4.99	5.36	6.39	5.86
.467	4.78	5.32	4.99	5.43	5.32	6.16	5.50
.487	4.84	5.16	—	5.56	5.76	5.89	5.54
.504	5.26	5.50	5.18	5.38	5.42	6.14	5.42

Table 9 (continued)

J. D. 2 400 000 +	50	51	52	53	54	55	56
35 920.547	5.40	5.69	5.29	—	5.40	6.27	5.40
.562	5.51	5.62	5.35	5.38	5.51	6.25	5.38
.585	5.66	5.78	5.43	5.48	5.30	6.18	5.66
35 933.415	5.58	5.52	5.40	5.69	4.86	4.82	5.48
.443	5.86	5.83	5.20	4.70	4.75	4.93	5.59
.479	5.95	5.84	5.77	4.66	4.75	5.36	5.67
.503	6.10	5.77	5.53	4.76	4.68	5.50	5.88
.515	6.03	5.99	5.57	4.88	5.21	5.70	5.82
.530	6.35	5.98	5.63	5.02	5.24	5.86	6.16
.543	—	5.87	5.44	4.97	5.19	—	5.96
.573	5.98	5.84	5.64	5.12	5.54	6.04	6.05
.588	6.35	5.96	5.42	5.10	5.12	5.78	5.94
.602	5.84	5.87	5.26	5.19	—	5.84	5.96
36 991.457	5.92	5.06	6.07	5.79	6.47	4.87	5.61
.470	6.40	5.27	6.61	5.98	—	4.87	5.55
.485	6.20	5.45	6.15	6.08	5.83	5.03	5.74
37 018.470	4.62	6.00	5.04	—	5.67	5.15	5.55
.483	4.57	5.99	5.28	4.78	5.50	4.92	5.63
.496	4.62	5.93	5.15	4.80	5.20	4.97	5.70
.510	4.90	6.00	5.42	5.08	5.61	—	5.75
.523	5.10	5.96	5.53	5.07	5.56	5.34	5.77
.537	5.25	5.89	5.26	5.26	5.79	5.27	5.69
.550	5.23	5.85	5.52	5.24	5.66	5.45	5.71
.563	5.46	6.36	5.50	5.48	5.86	5.48	6.07
.577	5.60	6.00	5.48	5.51	5.53	5.73	5.82
.609	5.84	6.27	5.86	5.51	5.78	5.72	5.94
.623	5.72	6.33	5.72	5.77	5.64	5.77	5.96
.637	6.00	6.26	6.03	5.74	6.03	5.77	6.06
37 057.539	5.31	5.84	6.15	5.92	6.02	6.40	6.11
.552	5.50	5.68	6.10	5.75	5.79	6.21	5.92
.578	5.67	5.84	6.19	—	5.92	6.20	5.45
37 058.529	5.29	6.12	6.12	5.69	5.50	6.29	6.01
.580	5.53	5.59	6.40	—	6.26	6.40	—
37 757.598	6.21	5.33	5.98	4.92	5.20	5.00	5.98
37 791.365	5.92	6.25	5.49	—	5.69	6.25	5.43
.380	5.89	6.07	5.52	5.72	5.40	6.16	5.61
.394	5.90	6.23	5.51	5.62	5.54	6.23	5.51
.424	5.89	6.02	5.70	5.01	5.38	6.27	5.69
.439	5.98	5.86	5.78	4.67	5.15	6.11	5.85
.454	5.91	5.53	5.57	—	4.95	5.64	5.85
.469	6.03	5.50	5.71	4.72	—	5.36	5.99
.483	5.90	5.12	5.69	4.81	5.34	5.02	6.09
.497	5.96	5.20	5.75	4.91	5.12	4.98	6.00
.519	6.14	5.22	5.90	5.05	5.36	5.13	6.07
.533	6.04	5.37	5.77	5.11	5.34	5.19	6.04
549	6.04	5.46	5.84	5.30	5.53	5.33	5.92
.563	6.12	5.46	5.98	5.40	5.70	5.43	6.00

Table 9 (continued)

J. D. 2 400 000 +	57	58	59	60	61	62	63
28 963.487	5.19	5.50	6.13	5.42	5.93	5.98	5.93
28 991.403	6.04	6.07	5.75	5.69	5.44	5.78	5.89
.416	6.20	5.75	5.60	5.84	5.34	5.75	5.93
.430	5.91	5.60	5.78	5.94	5.43	5.75	5.96
.522	5.96	5.55	5.99	5.89	5.61	5.87	6.12
.542	5.43	5.92	6.05	6.03	5.65	5.91	6.17
29 346.376	6.06	4.60	5.33	5.27	5.91	5.93	6.37
.392	6.24	4.95	5.54	5.38	5.85	5.77	6.09
29 719.549	5.70	6.09	6.49	5.70	6.31	6.02	6.21
.560	5.93	5.72	6.18	5.69	6.24	5.95	6.14
29 720.546	5.42	5.82	5.98	6.02	6.26	6.18	6.11
.558	5.41	5.76	6.07	5.97	6.17	6.09	6.15
29 774.405	5.84	5.52	5.19	5.84	5.49	6.00	5.27
.417	5.80	6.02	5.15	6.32	5.45	6.13	5.35
29 775.403	5.69	5.84	6.04	5.56	5.61	5.95	6.10
.415	5.83	5.85	6.07	5.56	5.59	5.76	6.21
.426	5.76	5.86	6.13	5.51	5.51	5.70	6.05
.437	5.85	5.91	6.10	5.90	5.39	5.66	6.10
.447	5.80	6.06	6.20	5.56	5.39	5.66	6.28
30 052.462	5.55	5.74	5.66	6.10	6.24	6.13	6.36
.474	5.67	6.13	5.76	6.09	6.21	6.17	6.25
.489	5.82	5.91	5.84	5.84	6.42	6.35	6.44
.501	5.80	6.12	5.89	6.24	6.12	6.32	6.24
30 078.418	6.14	5.79	5.88	5.79	6.22	5.92	5.29
.344	6.40	5.71	5.91	5.81	5.98	5.84	5.39
.470	5.27	5.81	5.85	5.73	6.11	5.93	5.66
.483	4.99	5.82	5.92	5.90	6.31	6.14	5.57
.498	4.80	5.72	5.80	5.83	6.16	6.02	5.60
.509	4.95	5.11	6.14	5.95	6.29	6.11	5.66
.521	5.23	5.02	6.16	5.91	6.16	6.07	5.79
.536	5.31	4.57	6.00	6.00	6.00	6.15	5.73
.548	5.29	4.59	6.20	5.94	5.89	6.18	5.64
33 390.397	5.07	5.01	6.07	5.57	6.45	5.40	6.00
.534	5.40	5.25	5.95	5.72	6.30	5.62	6.12
.545	5.51	5.38	6.02	5.88	6.22	5.71	6.09
.558	5.40	5.23	6.11	5.95	6.22	5.55	6.09
.570	5.69	5.31	6.03	5.76	6.17	5.78	6.05
.586	5.81	5.70	6.21	5.79	6.37	5.60	6.15
33 420.424	6.41	4.70	5.40	5.98	5.43	6.13	5.80
.438	6.07	4.79	5.75	6.12	5.65	5.90	5.52
.450	6.21	4.71	5.70	—	5.58	5.70	5.19
.476	6.09	4.92	5.77	6.07	5.56	5.72	5.04
.487	6.15	5.16	5.76	6.05	5.76	5.33	5.28
.498	6.10	5.13	5.75	5.84	5.79	5.35	5.25
.510	6.12	5.23	5.83	5.99	5.83	5.45	5.16
.523	—	5.27	—	6.42	5.61	5.34	5.21

Table 9 (continued)

J. D. 2 400 000 +	57	58	59	60	61	62	63
33 421.385	5.86	5.90	6.34	5.94	5.29	5.76	6.20
.442	5.94	4.81	5.92	5.51	5.21	5.97	6.26
.454	5.99	4.62	5.77	5.45	5.34	6.13	6.17
.465	5.92	4.62	5.54	5.34	5.19	6.05	6.23
.475	6.26	4.72	5.41	5.37	5.39	6.12	6.06
.486	—	4.66	5.29	5.27	5.39	6.17	6.10
.497	6.28	4.79	5.19	5.30	5.43	6.09	6.26
.535	6.47	5.11	5.50	5.56	5.54	5.96	6.43
.548	—	5.21	5.36	5.60	5.88	5.98	6.22
33 422.398	5.97	5.76	6.04	5.81	5.99	5.71	6.12
.431	6.11	5.95	6.31	5.91	5.25	5.59	6.41
.442	6.03	5.93	6.01	5.83	5.29	5.65	6.05
.452	6.29	5.50	6.41	5.89	5.23	5.46	6.20
.462	6.02	5.20	6.33	5.87	5.20	5.37	6.13
.472	6.15	4.81	6.35	5.91	5.09	5.42	6.12
.483	6.37	4.61	6.24	5.78	5.22	5.49	—
.493	6.17	4.65	6.15	5.90	5.41	5.72	6.20
.508	6.27	4.63	6.17	5.80	5.27	5.51	6.27
.520	6.12	4.66	6.50	5.72	5.43	5.43	6.15
33 763.406	5.21	5.51	6.08	5.43	6.21	6.06	5.72
.420	5.30	5.50	6.00	5.48	6.05	5.99	5.75
.442	5.50	5.52	6.08	5.54	6.12	5.88	5.85
.455	5.58	5.66	6.18	5.66	6.21	6.12	5.81
.464	5.71	5.65	6.18	5.62	6.28	6.05	5.87
.483	5.74	5.85	6.06	5.62	6.22	6.22	6.00
.494	5.73	5.72	6.26	5.68	6.17	6.01	5.94
.504	5.79	5.76	6.12	5.79	6.30	6.27	6.00
.514	5.85	5.92	6.25	5.78	6.32	6.23	6.02
.525	5.77	6.07	6.15	5.84	6.26	6.13	5.98
34 118.355	5.08	—	6.01	5.72	6.01	6.26	6.16
.372	5.15	—	5.90	5.99	5.68	6.02	6.20
.388	5.34	—	5.94	5.99	5.34	6.18	6.14
.428	5.58	5.47	6.15	6.22	5.12	6.22	6.22
.443	5.71	5.08	5.98	6.06	5.24	6.27	6.17
.470	—	4.52	5.94	5.92	5.60	6.38	—
.485	5.78	4.59	6.02	6.21	5.55	5.92	6.02
.499	5.76	4.61	6.09	5.87	5.82	5.99	6.16
.513	5.99	4.72	6.10	5.76	5.76	5.84	6.31
.526	—	4.88	6.00	5.68	5.60	5.32	5.78
.540	5.99	4.98	6.35	5.62	5.77	5.48	6.06
34 120.471	5.48	5.85	5.48	6.04	5.36	5.74	5.79
.484	5.62	—	5.57	6.05	5.35	5.75	5.81
.497	5.84	—	5.60	6.07	5.26	5.69	5.84
.510	5.76	5.26	5.66	6.02	5.29	5.53	5.96
.523	5.77	4.85	5.55	6.02	5.36	5.53	5.84
.536	5.64	4.53	5.64	6.13	5.33	5.48	5.75

Table 9 (continued)

J. D. 2 400 000 +	57	58	59	60	61	62	63
34 120.551	5.94	4.63	5.91	6.08	5.53	5.38	5.77
.564	5.98	4.61	5.98	6.29	5.63	5.59	6.13
.579	6.00	4.74	5.83	6.06	5.66	5.55	6.00
34 121.401	4.81	5.72	6.10	5.10	6.26	5.89	6.22
.412	5.00	5.81	6.20	5.20	6.26	6.02	6.17
.422	5.08	5.56	6.10	5.18	6.24	5.82	6.30
.431	5.21	5.70	6.04	5.21	6.00	5.90	6.04
.441	5.29	5.81	6.08	5.32	6.16	5.88	—
.484	5.68	5.91	6.09	5.30	5.73	6.06	5.34
.495	5.77	5.92	6.13	5.51	5.61	6.03	5.34
.505	5.67	5.78	5.98	5.51	5.59	6.12	5.25
.517	5.68	5.94	6.12	5.48	5.24	5.98	5.21
.528	5.66	5.71	5.92	5.60	5.30	5.97	5.27
.539	5.75	—	5.78	5.61	5.32	6.13	5.40
.552	5.88	4.83	5.61	5.68	5.27	6.03	5.30
.562	—	4.65	5.47	5.58	5.32	—	5.32
.594	5.77	—	5.31	5.63	5.66	6.20	5.72
.605	—	—	5.49	5.71	5.52	—	—
34 122.404	4.97	—	5.92	5.77	5.96	5.80	—
.416	4.89	—	5.87	6.04	6.00	5.92	6.20
.431	4.90	5.63	6.06	5.76	6.19	5.58	6.22
34 126.433	6.00	5.55	5.78	5.28	6.06	5.55	6.23
34 131.415	—	4.67	6.48	5.62	5.41	6.60	6.04
34 487.347	6.12	5.62	5.80	5.23	5.65	5.78	5.88
.367	6.22	5.74	5.72	5.36	5.76	5.92	5.96
.385	6.40	5.99	5.74	5.30	5.96	5.79	6.16
.397	6.14	5.52	5.72	5.40	5.84	6.07	6.02
.410	6.42	5.74	5.90	5.60	5.96	5.90	6.26
.428	—	—	5.99	5.59	6.02	5.78	6.15
.438	6.06	5.56	5.82	5.49	6.16	5.90	6.23
.449	6.09	5.70	5.98	5.67	6.29	6.03	6.33
.460	6.02	5.83	5.97	5.62	6.32	5.80	5.95
.474	5.88	5.87	5.92	5.68	6.01	6.05	6.24
.483	6.03	5.72	6.26	5.80	6.14	6.04	6.33
.494	—	—	—	5.73	5.81	5.88	6.29
.508	6.22	5.62	6.20	5.87	6.20	5.92	6.14
.518	—	5.82	6.12	5.84	6.04	6.00	6.10
34 488.530	6.08	5.56	5.59	6.02	6.34	5.52	6.11
.540	—	5.46	5.78	5.92	6.09	5.66	6.19
34 567.388	5.91	5.19	5.58	5.58	5.65	5.83	6.08
35 223.415	6.18	5.46	5.90	5.53	5.79	5.95	6.22
.428	5.97	5.18	5.86	5.56	5.86	6.05	6.13
.441	6.29	4.79	5.89	5.43	5.96	6.01	6.23
.467	6.02	4.67	5.90	5.55	5.95	6.10	5.88
.490	6.01	4.81	6.02	5.72	6.06	6.14	5.70
.503	6.02	4.91	5.93	5.69	6.02	6.11	5.69

Table 9 (continued)

J. D. 2 400 000 +	57	58	59	60	61	62	63
35 223.517	6.04	4.96	6.08	5.77	6.20	6.04	5.58
.530	—	4.96	6.01	5.73	6.26	5.97	5.38
.546	6.06	5.08	6.11	5.85	6.28	6.11	5.38
.573	—	5.18	6.07	5.87	6.26	6.22	5.50
35 224.454	6.08	5.42	5.29	6.02	5.72	5.51	6.08
.472	6.09	4.75	5.30	5.99	5.88	5.50	6.06
.485	6.18	4.58	5.28	6.10	5.97	5.59	6.14
.499	6.21	4.50	5.38	6.01	5.97	5.73	6.19
.512	5.94	4.62	5.42	5.96	6.03	5.68	5.94
.524	6.06	4.70	5.38	5.90	6.14	5.62	6.06
.542	5.94	4.92	5.53	5.94	6.23	5.65	6.24
.556	6.14	5.04	5.60	6.12	6.12	5.77	6.16
.569	—	—	5.71	6.29	6.35	6.03	6.20
.583	—	5.22	5.87	6.18	6.58	5.96	6.47
35 227.534	6.24	6.14	5.86	5.80	5.62	5.91	5.18
.547	6.12	5.82	5.85	5.56	5.70	6.14	5.46
.560	6.42	5.36	5.90	5.63	5.63	5.95	5.54
.573	—	4.97	6.15	5.25	5.58	—	5.46
.586	6.14	4.74	5.88	5.29	5.79	5.76	5.51
35 598.507	6.31	5.42	5.78	5.38	5.86	6.00	5.98
.524	6.24	5.54	6.04	5.46	5.88	6.02	5.99
.537	6.22	5.60	5.77	5.48	5.96	6.18	6.36
35 600.363	6.12	5.40	6.14	6.34	6.15	5.84	6.12
.378	5.75	4.83	5.75	6.05	6.05	5.66	6.16
.391	6.15	4.55	6.04	6.07	6.18	5.93	6.14
.405	6.05	4.69	6.07	5.84	6.16	5.82	6.16
.421	6.12	4.60	6.25	6.25	5.80	5.93	6.08
.434	6.12	4.92	5.95	6.19	5.42	5.99	6.25
.446	6.02	4.89	5.96	6.29	4.92	5.82	6.19
.501	6.04	5.21	6.27	5.61	5.18	5.92	—
.525	6.16	5.33	6.22	5.63	5.23	6.03	5.84
35 603.369	5.78	—	6.01	5.30	6.22	6.05	5.96
.381	—	—	6.08	5.28	6.34	5.94	5.80
.397	—	5.59	6.10	5.24	6.20	5.66	5.39
.408	5.88	5.52	6.21	5.17	6.26	5.59	5.15
.419	5.98	5.69	6.16	5.30	6.23	5.54	4.99
.431	6.08	5.96	6.22	5.43	6.20	5.54	5.08
.446	6.14	5.86	6.14	5.47	6.10	5.55	5.11
.457	6.13	5.57	6.10	5.42	6.25	5.37	5.18
.468	6.00	5.30	6.20	5.40	5.98	5.35	5.25
.491	6.10	4.68	6.32	5.52	6.18	5.45	5.42
.507	6.18	4.64	6.18	5.67	6.26	5.57	5.59
35 920.444	5.80	4.89	5.31	5.19	5.80	5.93	6.15
.467	5.85	4.82	5.40	5.11	5.90	5.67	6.22
.487	6.05	4.40	5.60	5.23	5.82	5.49	5.94
.504	5.81	4.69	5.62	5.26	6.01	5.53	6.05

Table 9 (continued)

J. D. 2 400 000 +	57	58	59	60	61	62	63
35 920.547	5.87	5.06	5.70	5.52	6.00	5.45	5.20
.562	6.00	5.00	5.83	5.58	6.32	5.51	5.17
.585	6.08	5.08	5.84	5.66	6.12	5.51	5.12
35 933.415	5.88	4.82	5.52	5.91	5.69	6.12	6.02
.443	5.90	4.84	5.52	5.86	5.79	6.03	6.00
.479	5.84	5.08	5.84	5.95	5.84	6.06	6.00
.503	6.23	5.03	5.88	5.59	6.25	5.72	5.98
.515	5.97	4.97	5.93	6.03	5.87	5.68	6.05
.530	—	5.43	5.74	5.81	6.14	5.49	6.08
.543	—	4.83	5.76	5.71	5.94	5.39	—
.573	4.64	5.02	5.74	5.93	6.28	5.64	6.45
.588	—	5.36	5.92	5.97	6.13	5.56	6.05
.602	4.83	—	5.91	5.61	6.15	5.89	6.02
36 991.457	5.97	5.40	5.12	5.66	5.87	5.93	6.05
.470	6.11	5.72	5.18	5.80	5.66	6.00	6.00
.485	—	5.53	5.29	5.87	6.08	6.28	5.97
37 018.470	5.24	5.67	6.08	5.84	5.51	5.78	6.00
.483	5.36	5.72	6.10	5.86	5.67	5.67	6.16
.496	5.55	5.49	5.70	5.93	5.73	5.75	6.10
.510	5.58	5.76	5.67	5.97	5.89	5.59	6.11
.523	5.45	5.72	5.54	6.00	5.84	5.59	5.96
.537	5.56	5.96	5.32	5.90	5.73	5.17	5.81
.550	5.77	5.62	5.26	5.86	5.83	5.37	6.07
.563	5.80	6.00	5.39	6.05	6.00	5.44	6.00
.577	5.90	5.79	5.35	6.05	5.95	5.35	5.38
.609	5.98	5.78	5.54	5.86	6.10	5.44	4.90
.623	—	—	5.63	6.04	—	5.77	5.40
.637	6.26	—	5.71	—	6.03	5.65	5.21
37 057.539	6.01	4.69	5.84	5.95	5.51	6.19	5.81
.552	5.95	4.85	5.79	6.13	5.57	6.06	5.81
.578	6.42	5.40	5.89	6.04	5.45	6.16	6.01
37 058.529	5.81	4.71	5.97	5.50	5.24	5.81	5.56
.580	—	5.08	5.59	5.73	5.26	6.26	5.31
37 757.598	5.36	4.61	5.61	6.20	5.00	6.07	—
37 791.365	5.03	5.49	6.18	6.07	6.43	6.11	6.25
.380	5.11	5.61	6.07	5.96	6.26	5.98	6.07
.394	5.17	5.69	6.08	5.97	6.14	6.09	6.04
.424	5.14	5.82	5.99	5.95	5.70	6.17	6.26
.439	5.63	5.46	6.08	6.03	5.35	6.07	6.15
.454	5.40	6.06	6.19	6.06	4.95	5.99	6.22
.469	5.59	5.69	6.12	6.04	5.08	6.03	5.85
.483	5.40	5.63	6.26	6.15	4.95	6.13	5.06
.497	5.64	5.70	6.04	6.10	5.20	6.10	4.99
.519	5.77	5.77	6.21	6.14	5.18	6.24	5.00
.533	5.74	5.80	6.38	6.23	5.37	6.15	5.03
.549	6.04	5.60	6.18	6.06	5.53	5.95	5.33
.563	6.00	5.63	6.20	6.06	5.73	6.06	5.30

Table 9 (continued)

J. D. 2 400 000 +	64	65	66	67	68	69	70
28 963.487	5.98	6.07	5.87	5.49	5.96	4.86	5.15
28 991.403	6.04	5.72	5.81	5.72	5.04	5.42	5.44
.416	6.15	5.81	5.78	5.67	5.14	5.78	5.78
.430	6.00	5.81	5.91	5.71	5.13	5.71	5.56
.522	5.85	6.13	5.45	5.66	5.40	5.52	5.22
.542	6.29	5.85	5.10	5.95	5.90	5.78	5.58
29 346.376	6.28	6.16	5.11	6.14	5.69	5.86	5.14
.392	6.12	5.90	5.26	6.01	5.75	5.73	5.26
29 719.549	5.80	6.16	5.85	5.94	5.97	5.97	5.47
.560	5.91	6.10	5.93	5.91	5.91	5.93	5.30
29 720.546	6.14	5.92	5.94	5.48	5.78	5.60	5.36
.558	6.17	5.88	5.80	5.64	5.80	5.57	5.32
29 774.405	6.36	5.41	5.71	5.49	5.80	5.93	5.55
.417	6.57	5.27	5.60	5.27	6.08	5.73	5.64
29 775.403	6.04	5.98	6.10	5.98	5.84	5.21	5.48
.415	6.09	6.02	5.97	6.04	5.91	5.33	5.47
.426	6.05	6.00	5.90	5.90	6.01	5.31	5.51
.437	6.10	5.90	5.80	6.10	6.02	5.42	5.44
.447	6.18	6.12	5.85	5.97	6.04	5.60	5.32
30 052.462	5.55	5.23	5.90	5.28	5.87	5.47	5.41
.474	5.46	5.11	6.04	5.46	5.85	5.06	5.34
.489	5.71	5.29	5.80	5.60	5.87	5.54	5.40
.501	5.51	5.18	6.01	5.64	5.97	5.73	5.38
30 078.418	5.90	6.22	5.92	6.18	6.05	6.03	5.43
.434	5.68	6.08	5.84	5.96	5.86	—	5.46
.470	5.43	5.75	5.88	5.62	6.03	5.35	5.62
.483	5.41	5.52	5.90	5.41	5.80	5.36	5.60
.498	5.38	5.30	5.74	5.12	5.49	5.27	5.64
.509	5.32	5.17	5.93	5.11	5.44	5.11	5.69
.521	5.53	5.12	5.99	5.06	5.36	5.32	5.74
.536	5.45	5.14	5.91	5.25	5.31	5.25	5.83
.548	5.51	5.13	5.89	5.23	5.38	5.29	5.75
33 390.497	5.87	5.87	5.49	6.50	5.49	6.07	5.59
.534	6.03	6.05	5.36	5.95	5.65	5.95	5.74
.545	5.95	5.95	5.54	6.00	5.69	5.75	5.69
.558	6.05	6.09	5.43	5.95	5.69	5.81	5.74
.570	5.83	5.89	5.40	5.87	5.69	5.80	5.69
.586	6.03	6.24	5.55	5.97	5.79	5.95	5.74
33 420.424	6.19	5.68	5.60	5.03	5.21	5.75	5.31
.438	6.26	5.98	5.95	5.16	5.34	5.85	5.46
.450	6.08	5.81	5.68	5.21	5.36	5.50	5.36
.476	6.30	5.64	5.56	5.26	5.26	5.74	5.26
.487	6.18	5.84	5.82	5.50	5.36	5.84	5.36
.498	6.14	5.68	5.75	5.43	5.39	5.79	5.28
.510	6.32	5.83	5.85	5.42	5.40	5.94	5.23
.523	6.27	5.94	5.54	5.54	5.31	5.76	5.16

Table 9 (continued)

J. D. 2 400 000 +	64	65	66	67	68	69	70
33 421.385	5.74	6.02	6.00	5.96	5.76	5.43	5.24
.442	5.90	6.16	5.88	6.07	5.03	5.01	5.16
.454	6.02	6.20	5.79	6.17	5.05	5.02	5.20
.465	5.86	6.13	5.48	6.15	4.99	5.10	5.27
.475	6.24	6.30	5.37	6.12	5.05	5.07	5.25
.486	5.91	6.15	5.29	6.05	5.16	5.41	5.19
.497	6.04	6.09	5.08	6.26	5.23	5.39	5.41
.535	6.12	5.16	5.19	5.08	5.54	5.61	5.47
.548	6.12	5.06	5.23	4.96	5.53	5.60	5.60
33 422.398	5.57	5.71	—	6.12	6.02	5.94	5.27
.431	5.39	5.75	6.08	6.23	5.65	6.11	5.47
.442	—	5.76	5.76	6.07	5.54	5.86	5.54
.452	5.33	5.73	5.89	6.02	5.46	6.33	5.40
.462	5.50	5.87	6.05	6.15	5.40	6.09	5.40
.472	5.45	5.74	5.91	6.12	5.42	6.27	5.39
.483	5.54	5.78	5.95	6.19	5.43	6.04	5.29
.493	5.72	5.98	5.90	6.00	5.63	6.19	5.51
.508	5.51	5.97	6.08	6.36	5.39	5.71	5.46
.520	5.50	5.69	6.20	5.86	5.33	5.27	5.46
33 763.406	5.72	5.98	5.76	6.04	5.98	5.91	5.56
.420	5.72	5.93	5.69	5.99	6.04	—	5.45
.442	5.73	5.95	5.75	6.04	5.95	5.95	5.39
.455	5.79	6.03	5.81	6.01	5.94	6.21	5.44
.464	5.89	6.01	5.80	6.05	6.01	6.18	5.49
.483	5.96	6.08	5.83	6.00	5.92	6.12	5.27
.494	5.94	6.11	5.83	6.09	5.75	6.01	5.40
.504	5.93	6.04	5.99	6.02	5.56	5.93	5.35
.514	6.02	6.02	5.97	6.12	5.36	6.02	5.29
.525	5.98	5.98	5.96	5.98	5.19	5.91	5.30
34 118.355	6.18	5.89	6.06	5.37	6.46	—	5.48
.372	5.99	6.20	6.19	5.43	5.90	—	5.33
.388	6.18	6.10	5.91	5.20	5.99	5.00	5.17
.428	6.20	5.99	5.85	5.44	5.79	5.19	—
.443	6.27	6.20	5.95	5.53	5.80	5.49	5.30
.470	6.36	6.12	—	5.77	5.89	—	5.22
.485	6.19	6.19	5.69	5.55	5.55	5.69	5.21
.499	6.16	6.26	5.82	5.63	5.52	6.09	5.20
.513	6.23	6.26	5.82	5.88	5.50	5.88	5.50
.526	5.82	5.82	5.51	5.93	5.42	—	5.40
.540	5.95	5.99	5.62	5.68	5.44	5.80	5.33
34 120.471	5.83	5.95	5.45	5.83	5.83	—	5.36
.484	5.72	6.12	5.52	5.93	6.00	—	5.45
.497	5.67	6.16	5.51	5.96	5.82	—	5.45
.510	5.42	6.43	5.51	6.06	5.70	—	5.53
.523	5.41	6.41	5.55	6.35	5.59	—	5.59
.536	5.33	6.18	5.57	6.13	5.24	—	5.64

Table 9 (continued)

J. D. 2 400 000 +	64	65	66	67	68	69	70
34 120.551	5.23	6.20	5.52	5.96	5.07	5.66	5.66
.564	5.50	6.38	5.63	6.02	5.19	5.78	5.73
.579	5.40	6.18	5.78	5.66	5.19	—	5.52
34 121.401	6.05	5.27	5.76	5.95	5.56	—	5.16
.412	6.18	5.28	5.93	5.84	5.59	—	5.20
.422	6.08	5.38	5.82	5.98	5.69	—	5.23
.431	6.14	5.47	5.90	5.86	5.62	—	5.27
.441	6.08	5.46	5.88	5.90	5.54	6.00	5.50
.484	6.24	5.64	5.80	5.95	5.75	—	5.56
.495	6.23	5.72	5.88	6.01	5.74	—	5.58
.505	6.10	5.76	5.85	5.88	5.81	—	5.63
.517	6.12	5.80	5.88	5.98	5.80	—	5.68
.528	6.08	5.71	5.76	5.91	5.71	—	5.60
.539	6.07	5.84	5.82	5.90	5.75	—	5.72
.552	6.03	5.79	5.74	6.03	5.74	—	5.68
.562	6.08	5.75	—	—	5.76	—	5.67
.594	6.20	5.94	6.01	5.97	5.55	—	5.74
.605	—	—	—	—	—	—	—
34 122.404	5.54	6.14	5.54	5.48	5.12	—	5.46
.416	5.65	5.96	5.47	5.40	5.13	—	5.47
.431	5.71	6.08	5.61	5.52	5.07	—	5.35
34 126.433	6.08	5.99	5.78	5.58	5.66	5.76	5.68
34 131.415	5.54	5.34	5.95	5.06	5.98	—	5.41
34 487.347	6.16	5.90	5.90	5.60	5.88	5.72	5.22
.367	5.94	6.00	5.92	5.76	5.84	5.84	5.36
.385	5.68	6.14	6.00	5.96	5.89	5.84	5.26
.397	5.66	5.82	5.96	5.70	5.70	5.68	5.12
.410	5.40	6.01	5.92	5.88	6.20	6.01	5.27
.428	5.40	6.00	5.82	5.89	5.81	5.89	5.34
.438	5.38	6.16	5.86	5.84	5.90	5.88	5.30
.449	5.41	6.41	6.00	5.93	5.87	5.85	5.35
.460	5.35	6.06	5.84	5.89	6.02	5.80	5.33
.474	5.50	6.25	5.68	5.91	5.85	5.85	5.25
.483	5.44	6.06	5.83	6.08	5.86	5.83	5.40
.494	5.40	6.20	—	—	—	—	5.44
.508	5.45	5.82	5.62	5.89	5.84	—	5.47
.518	5.72	5.53	5.92	6.04	5.64	6.05	5.50
34 488.530	6.21	5.81	5.81	5.75	5.93	5.59	5.51
.540	6.16	6.01	5.78	5.76	5.82	—	5.68
34 567.388	5.54	5.91	5.89	5.13	5.36	5.70	5.74
35 223.415	6.03	5.04	5.56	5.91	5.26	5.82	5.16
.428	6.07	4.98	5.66	5.88	5.22	5.45	5.22
.441	6.09	5.09	5.74	5.89	5.22	5.70	5.25
.467	6.14	5.19	5.69	5.84	5.37	5.82	5.27
.490	6.16	5.24	5.78	5.87	5.45	—	5.47
.503	6.11	5.30	5.81	5.95	5.47	5.89	5.56

Table 9 (continued)

J. D. 2 400 000 +	64	65	66	67	68	69	70
35 223.517	6.26	5.39	6.02	6.00	5.48	5.77	5.56
.530	6.26	5.45	5.82	6.01	5.51	5.65	5.61
.546	6.28	5.51	5.91	6.10	5.55	5.87	5.58
.573	6.26	5.62	6.05	6.05	5.78	—	5.58
35 224.454	5.86	6.08	5.34	5.60	5.04	5.35	5.46
.472	5.86	6.13	5.05	5.57	5.02	—	5.40
.485	5.88	6.02	5.02	5.64	5.13	5.59	5.56
.499	6.01	6.08	5.05	5.62	5.14	5.62	5.62
.512	5.91	5.94	5.08	5.78	5.27	5.63	5.56
.524	6.14	6.09	5.09	5.74	5.36	5.47	5.52
.542	6.24	6.01	5.14	5.65	5.77	5.72	5.74
.556	6.12	6.05	5.27	5.88	5.51	—	5.66
.569	6.03	5.91	5.36	5.79	5.61	—	5.71
.583	6.24	6.12	5.54	5.84	5.64	—	5.72
35 227.534	6.07	5.40	6.04	6.23	6.16	6.23	5.86
.547	5.95	5.40	5.43	6.30	6.08	—	5.76
.560	5.97	5.40	5.40	6.09	6.27	5.97	5.87
.573	5.91	5.56	5.16	6.12	6.09	—	5.54
.586	5.81	5.51	5.20	5.88	5.90	—	5.66
35 598.507	5.56	5.60	5.30	5.62	6.11	6.06	5.38
.524	5.81	5.61	5.54	5.67	6.04	5.92	5.49
.537	5.64	5.86	5.48	6.00	5.94	6.04	5.27
35 600.363	5.52	5.04	5.27	6.01	5.88	5.88	6.09
.378	5.66	5.04	5.40	5.82	5.55	5.70	5.38
.391	5.55	5.02	5.48	6.14	5.67	5.87	5.26
.405	5.77	5.03	5.42	5.86	5.58	6.03	5.29
.421	5.68	5.12	5.50	5.91	5.53	5.90	5.36
.434	5.86	5.32	5.56	5.88	5.51	5.79	5.25
.446	5.73	5.24	5.66	6.07	5.57	—	5.24
.501	6.27	5.56	5.88	6.04	5.88	5.95	5.20
.525	5.99	5.52	5.82	6.30	5.70	5.50	5.15
35 603.369	5.70	5.96	5.56	6.02	5.70	—	5.37
.381	5.69	5.94	5.37	5.92	5.78	—	5.37
.397	5.84	6.08	5.26	5.73	5.78	—	5.32
.408	5.73	6.04	5.20	5.37	5.75	—	5.27
.419	5.67	6.03	5.22	5.25	5.78	5.17	5.25
.431	5.77	6.12	5.35	5.07	5.84	5.28	5.25
.446	5.86	6.02	5.27	4.97	5.75	5.27	5.19
.457	5.94	6.15	5.40	5.06	5.94	5.32	5.26
.468	6.00	6.14	5.38	5.30	5.59	5.38	5.25
.491	5.89	6.00	5.50	5.32	5.68	5.45	5.29
.507	6.06	6.02	5.54	5.48	5.56	5.51	5.38
35 920.444	6.28	5.51	5.43	5.88	5.51	5.88	4.92
.467	5.97	5.24	5.60	5.94	5.60	5.80	5.36
.487	5.84	5.07	5.75	6.14	5.60	6.09	5.42
.504	5.57	4.94	5.50	5.81	5.66	6.01	5.26

Table 9 (continued)

J. D. 2 400 000 +	64	65	66	67	68	69	70
35 920.547	5.20	5.07	5.52	5.20	5.52	5.97	5.33
.562	5.20	5.00	5.62	5.09	5.74	6.38	5.41
.585	5.26	5.17	5.60	4.96	5.63	5.95	5.30
35 993.415	5.72	5.82	5.24	5.69	5.80	5.82	5.30
.443	5.91	5.65	5.33	5.99	5.80	5.78	5.30
.479	5.89	5.72	5.36	5.77	5.80	5.77	5.11
.503	5.98	5.93	5.50	5.93	5.69	5.72	5.03
.515	5.99	5.85	5.57	6.01	5.65	5.68	5.21
.530	6.08	6.08	5.39	6.00	5.24	6.00	5.13
.543	5.98	5.98	5.44	—	5.14	—	4.94
.573	6.28	6.18	5.84	5.97	4.97	5.91	5.12
.588	—	—	5.28	5.62	5.00	—	5.12
.602	—	—	5.66	5.46	5.19	—	5.19
36 991.457	6.30	5.87	5.28	5.50	5.87	—	5.43
.470	6.16	5.81	5.46	5.55	5.83	5.66	5.41
.485	5.97	6.13	—	5.56	5.81	5.93	5.53
37 018.470	5.93	—	6.13	6.20	5.93	—	5.57
.483	6.14	6.24	5.99	6.14	5.81	6.24	5.44
.496	6.06	6.00	6.10	6.44	5.78	—	5.44
.510	6.12	5.90	5.88	6.05	5.88	5.68	5.46
.523	6.01	5.99	5.89	6.18	5.84	5.60	5.36
.537	5.84	5.54	5.66	5.88	5.66	5.42	5.31
.550	6.07	5.38	5.78	6.01	5.62	5.57	5.41
.563	—	5.39	6.10	5.98	5.98	5.91	—
.577	6.18	5.08	5.90	5.55	5.73	6.06	5.43
.609	6.12	5.16	6.00	4.86	5.82	5.90	5.20
.623	—	5.27	6.06	5.07	5.94	5.67	5.35
.637	6.32	5.30	5.98	5.20	5.71	5.90	5.40
37 057.539	6.19	5.69	5.84	6.11	5.81	6.01	—
.552	5.87	5.75	5.81	6.13	5.95	5.92	5.30
.578	5.67	5.92	5.92	6.04	6.14	5.61	5.50
37 058.529	6.12	6.01	5.60	5.65	5.45	5.73	5.45
.580	6.06	6.51	5.79	6.06	5.64	5.88	5.59
37 757.598	5.88	5.98	5.68	5.72	5.00	—	5.12
37 791.365	5.85	5.60	5.74	5.85	5.60	6.25	—
.380	5.56	5.72	5.72	5.85	5.72	6.35	5.72
.394	5.55	5.77	5.67	5.95	5.67	6.08	5.57
.424	5.45	5.77	5.37	5.93	5.70	6.21	5.58
.439	5.42	5.82	5.40	5.98	5.68	—	5.48
.454	5.31	5.81	5.15	5.81	5.64	6.32	5.31
.469	5.52	5.84	5.32	5.84	5.61	5.88	5.39
.483	5.56	5.86	5.28	5.84	5.69	6.11	5.24
.497	5.64	5.93	5.33	5.71	5.55	6.01	5.24
.519	5.64	5.96	5.50	5.69	5.85	6.14	5.27
.533	5.60	5.98	5.37	5.50	5.74	6.20	5.19
.549	5.77	5.90	5.53	5.53	5.72	6.20	5.25
.563	5.76	6.20	5.60	5.46	5.89	5.63	5.23

Table 9 (continued)

J. D. 2 400 000 +	71	72	73	74	75	76	77
28 963.487	5.75	4.65	5.81	5.57	5.26	6.39	5.26
28 991.403	5.63	5.63	5.81	4.74	5.14	6.27	4.85
.416	5.64	5.81	5.93	4.77	5.28	6.23	4.64
.430	5.75	5.73	5.84	4.80	5.25	6.42	4.50
.522	5.59	6.20	5.68	5.35	5.50	6.30	5.28
.542	5.58	6.38	5.47	5.54	5.57	6.26	—
29 346.376	5.86	6.18	5.74	5.72	5.35	4.51	5.81
.392	6.10	6.60	5.90	5.73	5.49	4.85	5.97
29 719.549	5.80	6.42	5.80	6.11	5.85	5.99	5.28
.560	5.77	6.37	5.82	6.06	5.79	6.00	5.16
29 720.546	5.51	5.54	6.04	6.09	5.89	6.22	5.67
.558	5.54	4.88	5.97	5.97	5.85	5.74	5.69
29 774.405	5.78	5.06	5.90	4.93	5.47	5.16	6.10
.417	5.82	5.24	5.88	4.90	5.35	5.54	5.82
29 775.403	5.56	5.79	5.86	4.84	5.48	5.43	5.91
.415	5.49	5.76	5.76	4.84	5.47	5.17	5.91
.426	5.59	5.88	5.74	5.00	5.74	5.38	5.74
.437	5.64	5.78	5.78	5.14	5.51	5.57	5.80
.447	5.83	6.00	5.80	5.09	5.60	5.83	5.69
30 052.462	5.90	6.20	5.80	5.08	5.55	—	5.90
.474	5.83	6.38	5.80	4.80	5.76	5.90	5.73
.489	6.09	6.21	6.09	4.94	5.84	5.80	4.89
.501	6.01	6.35	6.04	4.98	5.99	6.50	4.62
30 078.418	5.17	6.32	5.99	6.16	5.46	5.43	5.94
.434	5.16	6.23	5.94	6.01	5.33	4.98	5.96
.470	5.43	6.17	5.81	5.97	5.43	5.04	5.85
.483	5.45	6.22	5.92	6.20	5.43	4.98	5.90
.498	5.51	6.20	5.89	6.10	5.56	5.12	5.89
.509	5.44	6.17	5.90	6.11	5.57	5.68	6.12
.521	5.65	6.29	5.68	5.91	5.62	5.99	5.99
.536	5.56	6.20	5.73	5.28	5.63	5.56	5.93
.548	5.66	6.07	5.62	4.90	5.64	5.43	5.84
33 390.497	5.92	6.21	5.94	6.34	5.75	5.84	6.13
.534	6.08	6.41	6.10	6.30	5.90	4.80	5.21
.545	6.02	6.22	6.00	6.22	5.85	4.85	4.73
.558	6.07	6.11	5.89	6.22	6.07	4.88	4.65
.570	6.03	5.78	6.01	6.17	6.03	5.07	4.92
.586	6.24	5.03	6.05	6.24	5.97	5.12	5.00
33 420.424	5.52	6.03	5.78	6.00	5.95	6.35	4.82
.438	5.31	6.26	5.85	6.05	5.98	6.36	5.03
.450	5.03	6.13	5.78	6.19	6.06	6.23	5.18
.476	5.10	6.35	5.74	6.09	5.96	6.31	5.19
.487	5.19	6.18	5.90	6.18	5.86	6.10	5.30
.498	5.10	6.16	5.79	6.52	5.73	6.22	5.48
.510	5.32	6.26	5.88	6.34	5.57	6.37	5.25
.523	5.27	—	5.88	—	5.25	—	5.59

Table 9 (continued)

J. D. 2 400 000 +	71	72	73	74	75	76	77
33 421.385	5.90	6.16	5.99	5.86	5.89	6.34	5.10
.442	5.94	6.48	5.92	6.03	5.66	—	5.64
.454	6.02	6.28	5.97	6.00	5.47	—	5.59
.465	5.92	6.17	6.05	6.09	5.42	5.90	5.38
.475	6.01	6.31	6.04	6.06	5.25	—	5.52
.486	—	6.30	6.20	6.17	5.27	—	5.73
.497	6.07	6.26	5.98	6.40	5.28	—	—
.535	5.08	6.27	5.92	6.29	5.44	—	
.548	4.97	6.27	6.00	6.31	5.36	—	—
33 422.398	6.02	6.34	5.71	6.20	5.40	6.34	6.07
.431	6.13	6.49	5.75	6.11	5.62	6.13	6.23
.442	6.08	6.30	5.79	6.20	5.54	6.18	5.96
.452	6.20	6.44	5.70	6.20	5.46	6.36	6.16
.462	5.99	6.36	5.60	6.56	5.37	6.50	6.13
.472	6.12	6.29	5.66	6.17	5.39	6.11	6.14
.483	6.24	6.29	5.64	6.42	5.43	5.98	—
.493	6.08	5.66	5.98	6.10	5.57	6.07	6.17
.508	6.03	5.25	5.94	6.25	5.51	5.85	5.88
.520	6.12	4.79	5.61	6.03	5.50	6.18	5.75
33 763.406	5.98	6.21	5.98	5.89	5.92	5.09	6.04
.420	5.89	6.11	5.89	5.91	5.97	5.30	5.86
.442	5.88	6.20	5.88	5.88	5.81	5.52	5.82
4.55	6.03	6.27	6.00	6.01	5.81	5.82	5.98
.464	6.03	6.38	6.05	6.01	5.76	5.93	6.10
.483	6.00	6.27	6.08	6.20	5.44	5.85	5.90
.494	5.88	6.35	5.96	6.09	5.40	5.85	5.85
.504	6.02	6.32	6.00	6.21	5.37	5.89	5.91
.514	6.10	6.23	6.02	6.19	5.36	—	5.47
.525	6.15	6.30	5.91	6.09	5.45	6.15	5.05
34 118.355	5.32	6.30	6.96	6.32	6.08	—	—
.372	5.33	6.25	6.00	6.19	5.60	—	—
.388	5.48	6.36	6.08	6.18	5.34	—	—
.428	5.41	6.28	5.69	6.25	5.26	6.58	5.78
.443	5.68	6.27	6.06	6.10	5.43	6.54	—
.470	—	5.44	6.10	—	5.64	—	5.89
.485	5.78	4.82	5.92	5.98	5.48	6.36	6.01
.499	5.76	4.72	5.90	6.16	5.52	6.36	5.84
.513	5.82	4.84	6.10	6.36	5.76	6.63	5.90
.526	—	4.95	6.37	—	5.57	—	—
.540	5.92	5.11	6.09	5.99	5.48	—	6.17
34 120.471	5.36	5.95	5.95	6.02	5.89	—	4.61
.484	5.35	6.19	6.14	6.22	6.00	—	4.83
.497	5.16	6.07	6.00	6.03	6.09	—	4.93
.510	5.26	6.19	6.04	6.12	6.06	—	5.29
.523	5.15	6.26	6.02	5.69	5.94	—	5.19
.536	5.16	6.09	6.00	5.06	5.86	—	5.21

Table 9 (continued)

J. D. 2 400 000 +	71	72	73	74	75	76	77
34 120.551	5.25	6.31	6.03	4.70	5.82	5.77	5.25
.564	5.28	6.13	6.18	4.74	5.86	5.37	5.34
.579	5.40	6.47	6.10	4.90	5.63	4.85	5.66
34 121.401	5.62	5.99	5.84	6.12	5.87	—	4.72
.412	5.79	6.11	5.86	6.26	5.98	—	4.88
.422	5.90	6.16	5.92	6.22	5.86	—	5.06
.431	5.66	6.16	5.78	6.10	5.86	—	5.12
.441	5.92	6.37	5.76	6.06	5.94	—	5.29
.484	5.91	6.20	5.70	6.26	5.86	—	5.43
.495	6.05	6.23	5.70	6.05	5.90	6.05	5.74
.505	5.98	6.30	5.76	5.83	5.83	—	5.56
.517	6.04	6.27	5.68	5.32	5.75	—	5.68
.528	5.97	6.24	5.71	4.87	5.57	—	5.60
.539	5.96	6.18	5.75	4.76	5.54	—	—
.552	5.72	6.18	5.79	4.86	5.44	—	—
.562	—	—	5.63	4.90	5.32	—	—
.594	5.12	6.06	5.77	5.25	5.33	4.95	—
.605	5.11	—	5.83	5.35	5.30	—	—
34 122.404	—	—	—	—	5.86	—	—
.416	5.65	6.29	5.84	6.00	5.94	—	—
.431	5.58	6.60	6.02	6.13	5.91	—	—
34 126.433	5.94	6.02	5.89	5.47	5.92	6.36	4.62
34 131.415	—	6.04	6.14	5.06	6.10	—	—
34 487.347	5.38	6.18	5.78	5.78	5.97	5.38	5.92
.367	5.52	6.46	5.92	5.78	5.96	5.07	—
.385	5.54	6.30	5.91	5.91	5.91	5.16	6.14
.397	5.54	6.16	5.72	5.82	5.72	5.04	5.84
.410	5.96	—	5.90	6.18	5.92	5.19	6.01
.428	—	6.05	5.99	5.96	5.52	5.34	5.95
.438	5.82	5.33	5.91	6.14	5.40	5.25	5.46
.449	5.60	5.11	6.09	6.23	5.41	5.49	5.16
.460	5.66	4.86	5.89	6.22	5.37	5.42	4.70
.474	5.68	4.84	5.82	6.06	5.29	5.55	4.72
.483	5.82	4.93	5.94	6.09	5.29	5.72	4.83
.494	—	5.04	—	—	5.44	5.57	4.83
.508	5.81	5.26	5.86	6.02	5.37	5.57	4.82
.518	5.78	5.30	5.95	6.05	5.55	5.90	5.10
34 488.530	5.70	6.06	5.75	6.28	5.87	5.77	—
.540	5.66	5.97	5.88	6.14	5.85	—	5.48
34 567.388	5.63	5.80	5.96	5.85	5.87	6.21	4.74
35 223.415	5.95	6.10	5.90	5.82	5.46	5.46	5.07
.428	5.97	6.30	5.90	5.39	5.45	5.09	5.25
.441	6.05	6.23	5.81	5.07	5.63	4.72	5.50
.467	6.02	6.24	5.86	4.79	5.76	4.90	5.53
.490	5.90	6.17	5.84	5.04	5.88	5.10	5.66
.503	5.73	6.31	5.95	5.19	5.89	5.35	5.50

Table 9 (continued)

J. D. 2 400 000 +	71	72	73	74	75	76	77
35 223.517	5.36	6.25	5.89	5.26	5.85	5.45	5.81
.530	5.11	6.19	5.87	5.26	5.97	5.38	5.63
.546	5.04	5.38	5.91	5.53	5.94	5.69	—
.573	5.07	4.79	6.03	5.60	5.85	—	—
35 224.454	6.02	5.49	5.95	4.88	5.98	4.99	5.54
.472	6.04	4.80	5.80	4.98	5.90	4.86	5.78
.485	6.04	4.88	6.08	5.13	6.08	5.08	6.04
.499	6.15	4.83	5.92	5.22	5.97	5.08	—
.512	5.96	5.02	5.84	5.27	6.05	5.24	5.84
.524	5.74	5.14	5.67	5.40	5.90	5.28	5.85
.542	5.94	5.39	5.77	5.74	5.90	5.79	6.01
.556	6.12	5.36	5.88	5.72	5.53	5.79	—
.569	—	5.48	5.85	5.68	5.48	5.74	—
.583	—	5.70	5.80	5.80	5.57	6.14	—
35 227.534	5.83	6.21	5.72	5.86	5.62	5.46	5.33
.547	5.85	6.49	5.80	5.80	5.64	—	5.59
.560	—	6.06	5.97	6.09	6.06	—	5.54
.573	—	6.09	6.21	6.23	6.04	—	5.53
.586	5.68	6.46	5.96	6.03	5.81	—	5.96
35 598.507	5.60	5.30	5.86	5.00	5.78	6.50	6.11
.524	5.49	5.52	5.86	5.36	5.99	6.17	5.96
.537	5.09	5.39	5.62	5.32	5.98	6.42	5.98
35 600.363	5.84	5.61	5.88	6.15	5.82	5.52	5.92
.378	5.75	5.50	5.72	5.92	5.72	5.80	6.09
.391	5.93	5.71	5.71	6.16	5.87	6.09	6.13
.405	5.80	6.09	5.88	5.68	5.82	5.78	6.07
.421	5.93	5.93	5.80	5.17	6.06	5.73	5.60
.434	6.10	6.01	5.77	4.90	5.83	6.19	5.05
.446	5.75	5.89	5.62	4.80	5.87	—	4.77
.501	6.12	6.27	5.64	5.31	5.61	6.50	5.05
.525	6.16	6.05	5.72	5.38	5.54	6.28	5.10
35 603.369	5.96	6.07	5.88	5.18	5.32	—	—
.381	—	6.34	5.94	4.90	5.37	5.92	5.55
.397	—	6.16	5.99	4.73	5.34	—	5.73
.408	5.97	6.31	6.02	4.86	5.41	5.97	6.12
.419	6.14	6.42	6.01	5.05	5.33	—	5.94
.431	5.87	6.26	6.00	5.08	5.46	6.06	6.20
.446	5.68	5.94	5.82	5.17	5.43	5.79	6.17
.457	5.59	5.29	5.89	5.29	5.50	6.40	6.17
.468	5.28	4.96	6.09	5.30	5.51	6.40	6.14
.491	5.08	4.96	5.94	5.48	5.60	6.34	6.18
.507	5.31	5.01	5.94	5.67	5.84	6.24	6.12
35 920.444	5.42	4.54	5.56	5.27	5.80	—	6.08
.467	5.50	4.64	5.64	5.60	5.94	5.85	6.14
.487	5.93	5.20	5.91	5.75	5,84	5.65	6.06
.504	5.91	5.26	5.84	5.73	5.81	6.24	6.12

Table 9 (continued)

J. D. 2 400 000 +	71	72	73	74	75	76	77
35 920.547	6.13	5.49	5.91	5.69	5.37	6.39	5.93
.562	5.83	5.62	5.98	5.74	5.27	6.56	5.92
.585	6.12	5.89	5.89	5.80	5.17	6.62	5.70
35 933.415	5.84	6.19	5.88	6.30	5.77	5.08	6.19
.443	5.70	6.30	5.96	5.97	5.30	5.06	5.54
.479	4.97	6.23	5.84	5.93	5.22	5.26	4.58
.503	4.94	5.95	5.86	6.05	5.27	5.83	4.56
.515	5.39	6.37	6.16	6.01	5.18	5.91	4.70
.530	—	6.22	5.98	5.98	5.30	5.89	4.70
.543	—	—	5.68	—	5.44	—	—
.573	5.06	—	6.12	5.84	5.64	5.81	5.27
.588	—	—	5.83	—	5.62	—	—
.602	4.80	—	6.00	—	5.68	—	—
36 991.457	5.61	5.70	5.75	6.15	6.13	5.92	5.50
.470	5.39	5.80	5.80	6.29	—	6.19	5.39
.485	—	6.03	5.71	6.04	5.97	—	5.71
37 018.470	5.46	—	6.05	5.84	5.98	—	4.74
.483	5.56	6.34	5.98	5.94	6.10	6.14	4.85
.496	5.54	6.39	6.00	6.10	5.98	5.93	4.62
.510	5.40	6.22	5.89	5.96	5.96	—	5.12
.523	5.59	6.31	5.98	5.99	—	6.14	5.11
.537	—	6.38	5.80	6.16	5.59	6.38	5.20
.550	5.64	6.03	5.95	6.00	5.77	5.76	5.55
.563	5.58	6.07	5.94	6.20	5.39	5.91	5.54
.577	5.88	6.18	5.78	6.20	5.55	5.89	5.74
.609	5.92	6.12	5.94	6.22	5.54	5.79	5.84
.623	5.82	6.06	5.96	6.24	5.52	—	5.82
.637	5.66	6.17	6.17	6.22	5.71	—	5.74
37 057.539	5.88	5.69	6.13	6.21	5.47	—	5.10
.552	5.79	5.65	5.87	6.31	5.47	6.07	5.01
.578	6.04	5.89	6.16	6.25	5.44	—	5.44
37 058.529	5.45	6.12	5.73	6.25	5.45	6.29	5.56
.580	—	6.11	5.36	6.35	—	6.63	—
37 757.598	—	5.74	5.74	5.20	5.36	—	5.30
37 791.365	—	5.60	5.78	5.92	5.69	6.58	6.35
.380	5.96	5.81	5.81	5.89	5.79	6.42	6.19
.394	5.83	5.77	5.69	5.97	5.81	6.52	6.04
.424	5.59	6.03	5.86	6.03	5.89	5.56	6.05
.439	5.45	5.98	5.87	5.88	5.88	5.12	6.10
.454	5.00	5.97	5.78	5.11	5.78	5.06	6.19
.469	5.25	6.16	5.94	4.73	5.84	5.08	6.25
.483	5.02	6.13	5.81	4.81	5.69	5.20	6.06
.497	5.04	6.28	5.92	4.77	5.61	5.44	5.79
.519	5.27	6.42	5.98	5.05	5.58	5.53	4.81
.533	5.23	6.28	6.04	5.11	5.26	5.71	4.61
.549	5.50	6.37	5.92	5.30	5.40	5.66	4.68
.563	5.50	6.39	5.98	5.40	5.43	5.86	4.83

Table 9 (continued)

J. D. 2 400 000 +	78	79	80	81	82	83	84
28 963.487	5.15	6.10	5.30	5.53	5.64	5.10	5.93
28 991.403	5.44	6.18	6.12	5.83	5.99	6.27	6.04
.416	5.25	6.02	6.20	5.34	6.24	6.13	5.91
.430	4.80	6.17	6.09	4.87	6.09	6.30	5.91
.522	4.44	5.47	4.97	5.47	6.23	5.22	6.00
.542	4.44	5.21	4.98	5.60	6.11	4.98	5.94
29 346.376	4.76	5.42	5.45	6.33	5.35	6.16	5.79
.392	4.77	5.49	5.57	6.28	5.93	5.21	5.85
29 719.549	5.58	5.55	5.14	5.44	6.16	5.99	6.09
.560	5.61	5.58	5.23	5.50	6.14	6.09	6.04
29 720.546	5.30	5.75	6.16	5.09	6.40	5.98	5.98
.558	5.26	5.85	6.11	5.06	6.21	6.03	5.88
29 774.405	5.49	6.50	5.68	6.53	5.49	6.47	6.03
.417	5.54	6.27	5.54	6.43	5.73	6.24	5.88
29 775.403	4.94	6.29	6.38	6.16	5.48	6.19	6.27
.415	4.97	6.21	6.21	6.21	5.42	6.30	6.19
.426	5.25	6.21	6.17	6.44	5.48	6.13	6.17
.437	5.20	6.32	5.98	6.05	5.75	6.10	6.07
.447	4.79	6.38	6.14	6.38	5.69	5.83	6.10
30 052.462	5.90	6.24	6.03	5.79	5.90	6.44	5.92
.474	5.57	5.67	6.02	5.90	6.07	6.38	6.09
.489	5.71	5.11	6.35	6.15	6.21	6.34	6.09
.501	5.80	4.95	6.35	6.10	6.15	6.29	6.01
30 078.418	5.26	6.59	6.37	6.03	6.29	6.09	5.79
.434	5.36	6.42	6.25	5.94	6.15	5.94	5.63
.470	5.26	6.43	6.19	6.05	5.08	6.09	5.73
.483	5.39	6.43	6.12	6.33	4.92	6.14	5.80
.498	5.39	6.09	6.13	6.13	4.93	6.13	5.81
.509	5.63	6.27	5.86	6.14	5.01	6.14	5.80
.521	5.53	6.26	6.03	6.12	5.16	6.18	5.99
.536	5.36	6.32	5.94	6.12	5.34	6.18	5.91
.548	5.43	6.49	5.91	6.18	5.49	6.14	5.98
33 390.497	5.67	5.84	5.38	5.13	6.07	4.90	5.59
.534	5.53	6.00	5.47	5.42	6.12	5.31	5.25
.545	5.42	6.00	5.39	5.45	6.22	5.39	5.23
.558	5.35	6.07	5.40	5.48	6.45	5.48	5.33
.570	5.25	6.03	5.47	5.69	6.05	5.50	5.40
.586	5.18	6.21	5.74	5.84	6.40	5.55	5.51
33 420.424	6.10	5.55	6.13	6.23	6.13	6.41	5.52
.438	5.83	5.90	6.15	6.36	6.36	6.15	5.73
.450	5.60	5.95	6.18	6.34	6.27	6.16	5.75
.476	5.77	6.15	6.09	6.18	6.31	6.56	5.87
.487	5.78	6.07	6.48	6.37	6.18	6.18	5.74
.498	5.79	5.96	6.00	6.08	6.55	6.55	5.71
.510	5.64	6.05	6.12	6.12	6.30	6.22	5.74
.523	—	6.15	5.99	6.23	—	—	5.83

Table 9 (continued)

J. D. 2 400 000 +	78	79	80	81	82	83	84
33 421.385	5.55	5.50	5.89	6.06	6.06	6.34	6.14
.442	5.56	5.97	6.05	6.27	6.20	6.24	6.13
.454	5.45	5.99	5.97	6.16	6.40	6.15	5.97
.465	5.40	6.05	6.00	6.23	6.29	6.13	5.82
.475	5.41	6.24	6.10	6.26	6.28	6.26	5.54
.486	5.03	6.27	6.22	6.22	6.22	6.34	5.41
.497	5.54	6.38	6.07	6.17	6.30	6.30	5.37
.535	5.90	6.12	6.35	6.45	6.60	5.35	5.14
.548	5.72	6.18	5.98	6.12	6.27	4.99	5.20
33 422.398	5.40	5.94	5.81	6.12	5.79	6.24	6.12
.431	5.00	6.29	5.91	6.08	6.05	6.20	6.08
.442	5.05	6.05	5.88	5.91	6.01	6.03	5.96
.452	5.09	6.41	6.02	6.06	6.29	6.20	6.16
.462	4.85	6.15	5.83	6.13	5.99	6.33	5.87
.472	4.96	6.12	5.83	5.93	6.49	6.32	6.06
.483	4.91	6.61	6.19	6.27	6.40	6.42	6.06
.493	5.11	6.35	6.05	6.35	6.46	6.29	6.23
.508	4.95	6.27	6.27	6.44	6.17	6.44	5.97
.520	5.08	5.91	5.83	6.05	6.61	6.08	5.89
33 763.406	5.29	6.29	6.20	6.29	6.00	4.81	5.92
.420	5.21	6.37	6.10	6.19	6.17	4.93	5.71
.442	5.36	5.63	6.14	6.14	6.02	5.12	5.37
.455	5.42	5.08	6.12	5.85	6.39	5.23	5.37
.464	5.49	4.85	6.15	5.44	6.20	5.32	5.29
.483	5.51	4.74	6.22	5.03	6.20	5.40	5.27
.494	5.36	4.85	6.26	4.90	6.13	5.55	5.31
.504	5.34	5.01	6.27	5.04	6.41	5.61	5.40
.514	5.49	5.02	6.36	5.05	6.42	5.68	5.36
.525	5.51	5.17	6.30	5.17	6.15	5.77	5.45
34 118.355	—	6.01	6.13	6.32	5.37	5.42	6.26
.372	—	5.84	6.10	6.12	5.81	5.53	6.02
.388	—	6.14	6.18	6.24	5.48	5.48	6.12
.428	5.08	6.15	5.82	6.22	5.82	5.85	6.08
.443	5.27	6.27	5.97	6.27	5.83	5.71	6.06
.470	5.58	—	5.89	—	5.69	6.06	5.64
.485	5.40	6.21	5.59	5.95	6.02	5.92	5.55
.499	5.29	6.49	5.55	5.42	6.03	6.16	5.40
.513	5.46	6.60	5.46	5.08	6.10	6.23	5.33
.526	5.48	5.82	5.54	5.16	5.86	5.95	5.19
.540	5.58	6.22	5.55	4.94	6.22	6.17	5.08
34 120.471	5.48	6.39	5.99	6.23	5.58	6.09	5.81
.484	—	6.44	6.00	6.32	5.66	5.98	5.77
.497	5.54	6.20	6.04	6.21	5.73	6.09	5.73
.510	5.58	6.48	6.19	6.28	5.63	6.12	5.98
.523	5.62	6.20	6.02	6.16	5.85	6.20	5.82
.536	5.51	6.15	6.00	6.02	5.84	6.20	5.72

Table 9 (continued)

J. D. 2 400 000 +	78	79	80	81	82	83	84
34 120.551	5.49	6.27	5.96	6.29	5.82	6.18	5.84
.564	5.55	6.48	6.07	6.27	6.07	6.27	6.11
.579	—	6.65	5.96	6.22	6.00	6.45	5.96
34 121.401	4.99	6.56	5.95	6.12	5.32	5.56	5.95
.412	5.18	6.37	5.98	6.36	5.09	5.66	6.37
.422	5.18	6.39	5.97	6.38	5.02	5.74	6.10
.431	5.32	6.15	5.96	6.15	5.00	5.78	5.99
.441	5.41	6.37	5.88	6.31	5.00	5.94	5.88
.484	5.30	6.24	5.95	6.09	5.26	5.89	5.37
.495	5.40	6.36	6.05	6.21	5.51	6.00	5.26
.505	5.32	6.20	6.07	6.13	5.56	5.97	5.35
.517	5.44	6.20	5.98	6.22	5.58	6.16	5.24
.528	5.42	6.22	5.97	6.16	5.69	5.99	5.27
.539	—	6.25	6.11	6.16	5.75	6.14	5.46
.552	—	6.22	6.10	6.25	5.78	6.20	5.39
.562	—	—	6.04	6.18	5.65	—	5.46
.594	—	5.28	6.18	6.20	5.71	6.32	5.53
.605	—	4.90	5.88	—	6.00	—	5.56
34 122.404	—	—	5.76	5.97	6.38	5.64	—
.416	5.54	6.30	5.87	6.00	6.25	5.68	5.91
.431	5.61	6.35	5.80	5.98	6.02	5.71	6.08
34 126.433	5.58	5.13	6.04	5.52	6.21	5.55	5.78
34 131.415	5.83	5.92	5.83	—	5.24	5.50	5.96
34 487.347	5.32	5.97	4.93	5.08	6.34	5.84	5.52
.367	5.36	6.18	5.07	5.40	—	5.69	5.60
.385	5.54	6.16	5.19	5.44	6.30	5.91	5.57
.397	5.50	5.94	5.17	5.48	6.12	5.84	5.56
.410	5.46	6.36	5.40	5.60	6.19	5.96	6.00
.428	—	6.11	5.45	5.74	6.15	6.42	5.72
.438	5.54	6.16	5.46	5.64	6.10	6.13	5.66
.449	5.70	6.23	5.53	5.91	6.36	6.35	5.93
.460	5.64	5.84	5.52	5.66	—	6.24	5.84
.474	5.70	5.48	5.58	5.70	—	6.38	5.83
.483	5.42	5.37	5.54	5.72	—	6.30	5.66
.494	5.84	5.07	5.71	5.84	—	6.18	5.84
.508	5.62	5.02	5.86	6.04	5.71	6.20	5.97
.518	5.60	5.04	5.75	5.90	5.30	—	5.95
34 488.530	5.10	5.49	5.68	5.91	6.28	6.28	5.42
.540	5.37	5.51	5.68	5.92	6.24	6.18	5.51
34 567.388	5.04	5.83	5.96	6.00	5.58	5.54	5.87
35 223.415	5.09	6.39	5.92	5.62	5.16	6.31	5.95
.428	5.11	6.26	5.84	5.79	4.93	6.22	5.92
.441	5.30	6.34	5.77	5.81	5.04	6.21	5.94
.467	5.17	6.39	5.19	5.84	5.14	6.22	6.04
.490	5.24	6.21	5.29	6.04	5.47	6.28	6.08
.503	5.17	6.32	5.33	5.97	5.45	6.11	6.11

Table 9 (continued)

J. D. 2 400 000 +	78	79	80	81	82	83	84
35 223.517	5.31	6.26	5.32	6.02	5.58	5.72	6.04
.530	5.26	6.11	5.45	6.13	5.60	5.16	5.97
.546	5.31	6.13	5.51	6.26	5.69	4.91	5.77
.573	5.32	5.45	5.69	—	5.75	5.10	5.43
35 224.454	5.44	6.28	6.02	5.42	5.37	6.41	5.88
.472	5.52	6.38	6.01	5.52	4.88	6.25	5.86
.485	5.56	6.26	5.83	5.62	4.95	6.24	6.10
.499	5.27	6.26	5.80	5.70	5.00	6.58	5.97
.512	5.24	6.14	5.70	5.70	5.08	6.03	6.02
.524	5.24	5.90	5.42	5.79	5.11	5.60	6.09
.542	5.02	5.32	5.22	6.03	5.24	5.02	5.86
.556	4.98	5.14	5.30	5.95	5.34	4.88	6.05
.569	4.89	5.10	5.36	5.94	5.61	5.04	5.96
.583	5.09	5.22	5.38	6.16	5.70	5.25	6.12
35 227.534	5.80	5.29	6.45	5.09	6.28	5.35	6.36
.547	5.67	5.56	5.95	5.04	6.24	4.99	5.88
.560	5.60	5.67	6.09	4.93	—	4.90	6.24
.573	5.28	5.74	6.02	5.05	6.30	5.00	6.45
.586	5.18	5.81	6.03	5.37	6.30	5.07	6.05
35 598.507	5.35	6.40	6.47	5.30	5.30	5.04	5.72
.524	5.20	6.26	6.27	5.54	5.52	5.10	6.02
.537	5.14	6.34	6.24	5.36	5.29	5.22	5.96
35 600.363	5.38	6.19	4.83	6.23	6.30	—	6.11
.378	5.20	6.41	5.02	—	6.32	6.27	5.99
.391	5.24	6.16	5.15	5.99	6.26	6.01	6.05
.405	5.27	6.01	5.34	6.50	6.16	6.07	5.96
.421	5.36	6.08	5.50	6.00	6.10	6.27	6.06
.434	5.43	6.60	5.35	6.46	6.31	6.35	6.15
.446	5.48	6.00	5.53	6.05	6.22	6.05	5.89
.501	5.51	6.38	5.90	6.39	6.38	4.94	6.10
.525	5.48	6.16	6.01	6.07	5.66	5.20	5.86
35 603.369	—	6.15	6.32	5.86	6.13	6.32	6.02
.381	5.19	6.25	6.18	5.98	6.00	6.20	6.00
.397	5.10	6.35	6.57	5.95	6.22	6.28	5.96
.408	5.01	6.28	6.29	5.95	6.02	6.25	6.04
.419	5.15	6.36	6.19	6.11	6.25	6.23	6.11
.431	5.52	6.40	6.24	6.10	6.10	6.31	6.02
.446	5.63	6.12	6.20	6.17	6.27	6.17	6.02
.457	5.37	6.15	6.22	6.22	6.23	6.24	6.15
.468	5.28	5.40	6.22	6.41	6.27	5.43	6.18
.491	5.29	4.96	5.96	6.12	6.38	4.96	5.98
.507	5.50	4.91	6.12	6.24	6.16	4.88	6.00
35 920.444	5.57	6.22	5.97	6.06	6.62	6.06	5.89
.467	5.70	6.38	6.22	6.22	6.33	5.97	5.97
.487	5.62	5.92	5.93	5.80	5.58	5.92	5.91
.504	5.91	6.14	6.01	6.14	5.02	6.03	5.93

Table 9 (continued)

J. D. 2 400 000 +	78	79	80	81	82	83	84
35 920.547	5.69	4.66	5.53	6.13	5.10	6.29	5.65
.562	5.77	4.69	5.34	6.12	5.17	6.38	5.38
.585	5.86	4.84	5.30	6.16	5.40	6.12	5.26
35 933.415	5.64	6.41	5.93	5.15	6.21	5.48	5.88
.443	5.90	6.15	5.71	5.22	6.41	5.86	5.78
.479	5.56	6.10	5.50	5.56	6.23	5.84	5.82
.503	—	6.32	5.24	5.56	5.93	5.93	5.98
.515	—	6.05	5.29	5.57	6.22	6.03	6.05
.530	5.58	6.08	5.27	5.98	5.89	6.29	6.03
.543	—	—	5.22	6.30	—	6.15	5.60
.573	6.00	5.60	5.53	6.10	6.18	6.26	6.28
.588	—	4.88	5.58	5.68	5.94	—	5.92
.602	—	4.68	5.57	6.17	5.08	—	5.80
36 991.457	5.03	6.16	5.10	6.21	6.20	4.76	5.98
.470	5.81	6.09	5.12	6.19	6.46	4.67	6.29
.485	5.51	6.08	5.35	—	—	4.99	6.01
37 018.470	5.93	6.21	5.50	6.48	5.80	6.34	6.26
.483	5.44	6.09	5.99	6.18	5.81	6.24	5.51
.496	5.68	5.93	5.86	6.18	5.83	5.72	5.55
.510	5.56	6.29	5.79	6.50	5.87	5.18	5.50
.523	5.42	6.18	6.12	6.06	5.93	4.90	5.29
.537	5.37	5.96	5.80	—	6.05	4.87	5.16
.550	5.62	6.26	6.11	5.94	6.03	5.13	5.32
.563	5.56	6.41	6.00	5.80	5.93	5.20	5.43
.577	5.84	6.22	6.09	5.22	6.14	5.36	5.50
.609	5.74	6.17	6.13	5.09	6.32	5.34	5.60
.623	5.82	6.04	—	5.07	6.42	5.46	5.60
.637	5.58	5.87	—	5.20	6.26	5.58	5.71
37 057.539	5.47	6.40	6.15	6.33	6.13	6.15	6.11
.552	5.67	6.19	6.10	6.19	6.10	6.34	6.01
.578	5.67	6.31	6.25	6.27	6.09	6.23	6.07
37 058.529	4.78	6.33	6.19	6.16	6.43	6.29	5.60
.580	5.64	6.54	—	6.51	6.48	6.20	5.79
37 757.598	—	—	6.25	—	6.17	6.08	5.88
37 791.365	6.14	6.32	6.21	6.25	6.03	6.25	5.64
.380	6.10	6.19	6.19	6.19	6.16	6.23	5.79
.394	6.02	6.21	6.34	6.29	6.21	6.37	5.73
.424	5.74	6.10	6.33	6.30	6.14	5.96	5.95
.439	5.77	5.98	6.29	6.10	5.55	5.28	5.97
.454	5.68	5.47	6.25	6.22	5.00	4.85	5.81
.469	5.81	5.32	6.25	6.23	4.99	4.95	5.91
.483	5.56	5.20	6.19	6.35	4.92	5.09	5.90
.497	5.83	5.20	6.00	6.12	5.13	5.20	5.90
.519	5.96	5.41	6.19	6.27	5.36	5.36	6.04
.533	5.80	5.47	6.18	6.32	5.40	5.47	6.02
.549	5.60	5.62	5.90	6.34	5.50	5.50	6.04
.563	5.43	5.70	5.57	6.41	5.46	5.63	6.16

Table 9 (continued)

J. D. 2 400 000 +	85	86	87	88	89	90	91
28 963.487	5.67	5.26	5.15	5.78	5.64	5.96	6.22
28 991.403	5.38	5.78	5.10	5.04	5.35	5.86	5.81
.416	5.42	6.06	5.08	4.93	5.30	5.98	6.02
.430	5.25	5.87	5.00	5.00	5.36	6.10	5.94
.522	5.34	5.50	4.98	5.08	5.32	6.02	6.12
.542	5.30	5.22	5.14	5.33	5.84	6.14	6.29
29 346.376	5.91	5.74	4.99	4.96	5.72	4.87	4.90
.392	5.90	6.10	5.23	5.38	5.81	4.99	5.23
29 719.549	5.76	—	5.18	5.47	5.97	6.02	6.28
.560	5.64	—	5.19	5.64	5.77	6.24	6.14
29 720.546	5.42	5.51	5.51	5.73	5.87	6.20	6.18
.558	5.32	5.44	5.44	5.34	5.76	6.00	6.21
29 774.405	5.93	5.38	5.38	5.38	5.84	6.19	5.68
.417	6.00	5.51	5.54	5.45	5.98	6.00	5.88
29 775.403	5.95	5.63	5.29	5.43	5.93	6.10	5.61
.415	5.73	5.94	5.25	5.62	6.02	6.19	5.68
.426	5.81	5.76	5.38	5.51	5.83	6.15	5.70
.437	5.76	5.93	5.51	5.85	5.98	6.29	5.93
.447	5.78	6.04	5.60	6.16	5.69	6.16	5.75
30 052.462	5.41	5.53	5.39	—	6.09	6.15	6.24
.474	5.49	5.37	5.26	5.40	6.02	6.11	6.25
.489	5.45	5.60	5.48	5.42	6.11	6.25	6.07
.501	5.45	5.75	5.64	5.40	5.85	6.15	6.17
30 078.418	5.41	5.95	5.35	5.76	5.35	6.20	6.16
.434	5.33	5.79	5.20	5.79	5.23	6.06	6.18
.470	5.32	5.52	5.29	5.18	5.54	5.81	6.24
.483	5.45	5.48	5.25	4.98	5.45	5.45	6.08
.498	5.38	5.47	5.27	5.12	5.51	5.07	5.97
.509	5.23	5.41	5.32	5.29	5.71	4.80	5.95
.521	5.45	5.62	5.42	—	5.72	4.91	5.91
.536	5.56	5.53	5.38	5.22	5.76	5.11	5.31
.548	5.49	5.64	5.31	5.10	5.80	5.13	4.94
33 390.497	5.31	5.36	5.66	5.22	5.90	6.34	5.57
.534	5.45	5.47	5.33	—	5.90	6.30	5.62
.545	5.51	5.51	5.25	5.22	5.98	6.22	5.85
.558	5.45	5.48	5.21	5.31	5.45	6.22	5.77
.570	5.69	5.60	5.24	5.28	5.24	6.17	5.71
.586	5.79	5.88	5.28	5.34	5.00	5.97	5.97
33 420.424	5.43	5.68	5.66	5.37	5.80	6.29	6.00
.438	5.83	5.90	5.58	5.46	5.98	6.32	6.24
.450	5.80	5.81	5.65	5.44	5.89	6.28	6.27
.476	5.74	5.82	5.62	5.69	5.74	6.09	6.27
.487	5.84	6.15	5.68	5.55	5.84	6.11	6.05
.498	5.79	5.81	5.48	5.56	5.96	6.34	6.12
.510	5.83	5.99	5.38	5.66	6.05	6.22	6.14
.523	5.94	—	5.16	5.27	5.78	—	—

Table 9 (continued)

J. D. 2 400 000 +	85	86	87	88	89	90	91
33 421.385	5.31	6.00	5.26	5.60	5.26	6.02	6.06
.442	5.35	5.97	5.56	5.38	5.59	6.11	5.99
.454	5.27	5.80	5.47	5.38	5.47	6.04	—
.465	5.27	5.68	5.48	5.23	5.42	6.25	6.29
.475	5.34	5.58	5.54	5.10	5.54	6.13	6.28
.486	5.34	5.44	5.59	5.07	5.65	6.34	6.12
.497	5.53	5.21	5.56	5.10	5.75	6.32	6.30
.535	5.61	5.44	5.82	5.06	5.92	6.58	6.24
.548	5.63	5.39	5.41	—	5.86	6.24	6.18
33 422.398	5.79	5.57	5.24	5.03	5.00	6.32	5.99
.431	5.44	—	5.42	5.00	5.07	6.41	6.08
.442	5.65	5.73	5.32	5.15	5.15	6.03	5.96
.452	5.46	5.73	5.36	5.03	5.06	6.41	6.16
.462	5.35	5.65	5.25	—	5.22	6.30	5.89
.472	5.28	5.88	5.39	5.09	5.19	6.29	6.29
.483	5.29	5.64	5.46	5.02	5.29	6.24	6.12
.493	5.47	5.82	5.51	5.08	5.41	6.20	6.46
.508	5.36	6.03	5.39	5.13	5.25	6.06	6.17
.520	5.30	5.89	5.46	5.27	5.43	6.55	6.12
33 763.406	5.45	5.63	5.27	5.26	5.84	4.93	6.29
.420	5.45	5.66	5.27	5.42	5.78	4.95	6.25
.442	5.60	5.70	5.28	5.63	5.81	5.07	6.19
.455	5.62	5.77	5.34	5.71	6.05	5.27	6.18
.464	5.76	5.84	5.44	5.77	5.91	5.35	6.20
.483	5.80	6.00	5.37	5.62	6.05	5.62	6.23
.494	5.81	5.96	5.40	5.50	5.88	5.52	6.31
.504	5.91	6.08	5.42	5.67	5.89	5.64	6.34
.514	5.97	6.16	5.55	5.66	5.85	5.63	6.12
.525	5.91	6.09	5.61	5.74	5.53	5.61	6.17
34 118.355	5.82	5.34	5.48	—	—	—	5.54
.372	5.43	5.26	5.36	—	—	—	—
.388	5.24	5.48	5.20	—	5.34	6.20	5.50
.428	5.12	5.58	5.12	5.76	4.84	6.31	5.72
.443	5.30	5.80	5.60	5.62	4.88	6.12	5.80
.470	—	—	5.49	5.06	5.19	6.26	5.69
.485	5.25	5.98	5.36	5.13	5.00	6.04	6.09
.499	5.33	6.16	5.40	5.12	5.20	6.16	5.99
.513	5.46	5.99	5.60	5.19	5.16	6.29	6.07
.526	5.32	—	5.60	5.22	5.22	6.28	6.00
.540	5.58	6.09	5.51	5.51	5.37	6.22	6.22
34 120.471	5.74	5.79	5.22	5.58	5.87	6.20	5.56
.484	5.66	5.77	5.30	—	5.66	6.20	5.57
.497	5.48	5.87	5.23	5.71	5.87	6.09	5.60
.510	5.48	5.86	5.26	5.50	5.89	6.12	5.59
.513	5.44	6.04	5.10	5.55	5.79	6.11	5.64
.536	5.36	5.97	5.00	5.33	6.00	6.15	5.72

Table 9 (continued)

J. D. 2 400 000 +	85	86	87	88	89	90	91
34 120.551	5.32	6.08	5.00	5.32	5.96	6.10	5.71
.564	5.40	6.02	5.25	5.15	5.88	6.20	5.86
.579	5.28	6.08	5.19	5.14	5.55	6.22	5.88
34 121.401	5.78	5.91	5.51	5.60	5.74	6.05	6.12
.412	5.81	6.10	5.59	5.50	5.74	6.12	6.02
.422	5.92	6.02	5.59	5.44	5.69	6.10	5.69
.431	5.90	5.99	5.66	5.40	5.85	5.97	5.54
.441	5.81	6.00	5.65	5.21	5.83	6.14	5.46
.484	5.86	6.02	5.72	5.15	5.97	6.16	5.20
.495	5.94	5.90	5.70	5.22	5.81	6.20	5.40
.505	5.96	5.85	5.59	5.25	5.90	6.16	5.35
.517	5.96	5.75	5.48	5.31	5.86	6.22	5.41
.528	5.81	5.54	5.40	5.24	5.86	6.09	5.60
.539	5.75	5.54	5.35	—	5.92	6.13	5.48
.552	5.65	5.44	5.27	—	5.98	6.15	5.52
.562	5.47	5.43	5.02	—	5.70	—	5.65
.594	5.36	5.33	5.00	5.53	5.74	5.97	5.60
.605	5.59	5.46	5.16	—	—	—	5.73
34 122.404	5.38	5.60	5.33	5.16	5.61	5.90	6.25
.416	5.40	5.45	5.36	5.16	5.47	6.00	6.29
.431	5.52	5.52	5.35	5.37	5.68	6.13	6.28
34 126.433	5.85	5.97	5.47	5.63	5.84	5.38	6.06
34 131.415	5.98	—	5.62	5.49	5.83	6.10	6.10
34 487.347	5.65	5.50	5.20	5.76	5.88	5.60	5.23
.367	5.43	5.55	5.36	5.98	5.89	5.84	5.50
.385	5.54	5.47	5.42	5.79	5.91	5.74	5.57
.397	5.33	5.36	5.30	5.43	5.74	5.74	5.72
.410	5.35	5.57	5.57	5.40	6.09	6.22	5.82
.428	5.20	5.63	5.45	5.18	—	5.92	5.74
.438	5.25	5.58	5.60	5.04	6.06	5.93	5.58
.449	5.41	5.83	5.60	5.21	6.12	6.03	5.85
.460	5.28	5.60	5.60	5.07	6.06	6.33	5.99
.474	5.29	6.68	5.55	5.04	5.85	5.90	5.90
.483	5.44	5.96	5.50	5.23	5.86	6.28	5.87
.494	5.44	6.07	5.50	5.12	5.85	—	—
.508	5.47	5.99	5.78	5.08	5.69	—	—
.518	5.59	6.05	5.73	5.30	5.43	6.13	—
34 488.530	5.30	5.42	5.75	5.66	5.97	6.21	5.89
.540	5.37	5.44	5.71	5.83	—	6.03	5.99
34 567.388	5.78	5.85	5.10	5.63	6.14	5.04	5.20
35 223.415	5.99	5.51	5.20	5.53	5.90	6.18	6.27
.428	5.92	5.47	5.22	5.60	5.79	6.18	6.21
.441	5.81	5.48	5.40	5.59	5.87	6.25	6.20
.467	5.88	5.55	5.30	5.51	5.73	5.84	6.37
.490	5.92	5.72	5.52	5.43	5.85	5.12	6.26
.503	5.73	5.73	5.54	5.44	5.89	4.86	6.20

Table 9 (continued)

J. D. 2 400 000 +	85	86	87	88	89	90	91
35 223.517	5.60	5.93	5.63	5.09	5.93	4.90	6.17
.530	5.38	5.84	5.61	5.04	5.81	5.04	6.28
.546	5.42	5.89	5.60	5.04	5.98	5.18	6.13
.573	5.32	6.05	5.60	5.05	5.32	5.32	6.29
35 224.454	5.72	6.00	5.06	5.04	5.95	6.19	5.95
.472	5.86	6.04	5.02	4.94	5.78	6.34	6.09
.485	5.88	6.04	5.24	5.13	5.97	6.12	6.12
.499	6.01	6.06	5.22	5.05	5.86	6.15	6.10
.512	5.86	5.91	5.30	5.16	5.78	5.35	6.34
.524	5.82	5.88	5.28	5.21	5.72	4.98	6.22
.542	5.92	5.65	5.34	5.30	5.86	4.88	6.14
.556	5.86	5.43	5.30	5.53	5.88	4.96	6.10
.569	5.76	5.36	5.61	5.65	5.85	5.18	6.12
.583	5.56	5.54	5.59	5.62	5.94	5.38	6.34
35 227.534	5.40	5.40	5.88	5.29	5.59	6.12	5.72
.547	5.26	5.46	5.62	5.40	5.48	6.56	5.73
.560	5.24	5.42	5.70	5.52	5.63	6.50	6.20
.573	5.38	—	5.94	5.74	5.44	—	6.02
.586	5.40	5.51	5.74	5.48	5.96	6.23	5.88
35 598.507	5.86	5.94	5.51	5.06	6.09	5.78	5.04
.524	5.96	6.22	5.63	5.05	5.88	6.04	5.24
.537	5.70	5.98	5.75	5.22	5.77	5.66	5.17
35 600.363	5.42	5.52	5.66	5.40	5.72	6.60	6.30
.378	5.38	5.33	5.52	5.48	5.28	5.98	5.98
.391	5.24	5.44	5.69	5.72	5.08	5.55	6.18
.405	5.39	5.55	5.80	5.34	4.85	5.03	6.20
.421	5.25	5.50	5.53	5.46	4.90	4.97	6.10
.434	5.35	5.58	5.51	5.53	5.03	5.03	6.44
.446	5.29	5.70	5.36	5.60	5.08	4.99	6.30
.501	5.49	5.90	5.10	5.69	5.46	5.44	—
.525	5.61	5.99	5.18	5.38	5.50	5.66	6.44
35 603.369	5.59	5.70	5.03	—	5.59	6.17	5.63
.381	5.78	5.76	5.03	5.60	5.71	6.25	5.73
.397	5.91	6.01	5.01	5.59	5.73	6.18	5.76
.408	5.69	5.84	5.06	5.62	5.64	6.10	5.75
.419	5.93	6.06	5.20	5.76	5.88	6.33	6.06
.431	5.94	6.20	5.14	5.63	5.74	6.28	6.02
.446	5.86	6.02	5.19	5.53	5.75	6.29	5.96
.457	5.95	6.10	5.47	5.68	5.91	6.56	6.04
.468	5.86	6.22	5.33	5.73	5.98	6.40	6.18
.491	5.82	5.94	5.42	5.62	5.73	5.78	6.10
.507	5.86	6.02	5.60	5.44	5.86	5.20	6.16
35 920.444	5.70	5.71	4.92	5.73	5.49	5.01	6.02
.467	5.80	5.76	5.03	5.70	5.53	4.82	5.97
.487	5.70	5.49	5.23	5.77	5.84	5.14	6.20
.504	5.93	5.42	4.94	5.24	5.50	5.03	5.99

Table 9 (continued)

J. D. 2 400 000 +	85	86	87	88	89	90	91
35 920.547	5.60	5.25	5.10	5.30	5.77	5.52	6.17
.562	5.30	5.30	5.09	5.20	5.55	5.51	6.19
.585	5.30	5.43	5.08	5.23	5.60	5.51	6.16
35 933.415	5.22	5.34	5.30	5.62	5.04	4.82	6.24
.443	5.22	5.52	5.30	5.94	5.33	5.33	6.08
.479	5.29	5.74	5.29	5.75	5.36	5.29	5.72
.503	5.14	5.50	5.30	5.79	5.27	5.44	5.11
.515	5.39	5.85	5.50	5.69	5.39	5.57	5.33
.530	5.52	5.86	—	5.82	5.41	5.84	5.13
.543	5.76	6.00	5.14	—	—	5.83	5.19
.573	5.60	5.81	5.48	5.70	5.30	5.74	5.41
.588	5.77	5.74	5.28	—	5.42	5.68	5.38
.602	5.66	—	4.90	—	5.84	6.02	5.26
36 991.457	5.63	5.82	5.74	5.56	5.42	5.74	6.40
.470	5.81	6.06	5.55	5.52	5.81	6.11	—
.485	5.71	—	5.33	5.45	5.68	6.07	6.39
37 018.470	—	6.03	5.62	5.06	5.95	6.39	6.01
.483	5.98	6.03	5.62	5.06	5.94	6.18	6.12
.496	5.85	6.10	5.73	4.90	5.51	6.27	6.02
.510	5.88	5.96	5.90	4.96	5.85	6.09	6.06
.523	5.94	5.79	5.71	5.02	5.70	5.99	6.12
.537	5.70	5.40	5.73	5.34	5.85	6.02	6.38
.550	5.85	5.48	5.70	5.42	5.83	6.11	6.19
.563	5.98	5.64	5.79	5.40	5.91	6.41	6.16
.577	5.90	5.63	—	5.41	6.05	6.32	6.18
.609	5.74	5.58	5.51	5.34	5.88	5.66	6.27
.623	5.72	5.67	5.67	5.44	6.56	5.61	6.56
.637	5.46	5.60	5.71	5.58	6.22	5.13	6.60
37 057.539	5.44	5.57	5.81	4.90	6.02	5.77	5.60
.552	5.53	5.67	5.95	4.87	5.86	5.53	5.60
.578	5.85	6.04	5.45	5.27	6.12	6.09	5.75
37 058.529	5.35	6.05	5.81	5.22	5.73	5.50	5.13
.580	5.42	—	—	5.47	6.35	6.02	5.69
37 757.598	5.88	5.63	4.94	—	4.90	5.81	5.98
37 791.365	5.96	6.03	—	5.37	5.54	6.03	5.85
.380	5.85	5.98	5.46	5.72	5.81	6.23	6.07
.394	5.97	5.98	5.51	5.93	5.72	6.18	5.90
.424	5.69	5.76	5.44	5.78	5.69	6.04	6.18
.439	5.68	5.55	5.61	5.77	5.85	6.17	6.14
.454	5.40	5.44	5.25	5.44	5.72	6.06	6.29
.469	5.52	5.51	5.30	5.84	5.74	6.12	6.22
.483	5.40	5.20	5.16	5.53	5.74	6.00	6.04
.497	5.29	5.44	5.05	5.43	5.62	5.95	6.26
.519	5.27	5.53	5.13	5.05	5.92	6.21	6.09
.533	5.19	5.50	4.92	5.23	5.47	6.12	6.28
.549	5.33	5.66	5.16	5.07	5.22	6.24	6.24
.563	5.46	5.73	5.15	5.12	4.90	6.16	6.18

Table 9 (continued)

J. D. 2 400 000 +	92	93	94	96	97	99	100
28 963.487	6.13	6.01	5.57	5.93	5.87	5.71	5.78
28 991.403	5.89	6.27	6.20	6.01	5.38	5.67	5.44
.416	5.93	6.06	6.06	5.84	5.60	5.93	5.46
.430	5.94	6.11	6.28	5.99	5.71	5.81	5.25
.522	6.23	5.82	6.12	5.97	6.03	5.77	4.86
.542	6.26	5.58	6.17	5.92	6.11	5.64	5.12
29 346.376	5.45	5.30	6.12	5.45	5.55	5.05	5.74
.392	5.81	5.57	5.95	5.71	5.59	5.44	5.87
29 719.549	5.97	6.07	6.16	5.97	5.64	5.85	5.97
.560	.600	6.04	5.93	5.89	5.69	5.85	5.82
29 720.546	5.98	5.85	6.18	5.96	5.57	5.62	5.60
.558	5.88	5.85	6.29	5.83	5.54	5.57	5.57
29 774.405	5.49	5.84	—	5.61	5.52	5.68	5.58
.417	5.70	6.00	6.19	5.64	5.54	5.73	5.60
29 775.403	5.72	5.93	6.19	5.56	5.53	5.43	5.98
.415	5.76	6.07	6.48	5.76	5.36	5.33	5.94
.426	5.88	6.00	6.33	5.48	5.48	5.38	5.83
.437	5.85	5.98	6.29	6.10	5.42	5.33	5.78
.447	5.85	5.88	6.16	5.66	5.47	5.53	5.66
30 052.462	5.85	5.80	6.08	4.81	5.53	5.20	5.87
.474	6.09	6.07	6.33	4.80	5.70	5.34	5.85
.489	6.02	5.75	6.07	4.94	5.71	5.51	6.09
.501	6.22	6.01	6.26	5.15	5.94	5.61	6.20
30 078.418	5.23	6.01	5.56	4.81	6.03	5.41	5.79
.434	4.87	6.11	5.63	4.69	5.98	5.30	5.76
.470	5.27	6.05	5.79	5.08	5.75	5.27	5.79
.483	5.20	5.94	5.92	5.05	5.65	5.29	5.94
.498	5.44	5.89	5.78	5.20	5.58	5.27	5.89
.509	5.44	6.11	5.93	5.27	5.53	5.44	5.86
.521	5.50	6.20	6.03	5.42	5.68	5.68	5.99
.536	5.56	6.06	6.12	5.53	5.50	5.60	5.81
.548	5.69	5.94	6.02	5.62	5.51	5.60	5.94
33 390.497	6.14	6.07	6.18	6.34	6.14	5.46	5.94
.534	6.05	6.12	6.15	6.05	5.95	5.60	5.74
.545	6.28	6.35	6.37	6.02	6.07	5.67	5.51
.558	6.17	6.11	6.45	5.59	6.07	5.69	5.45
.570	6.03	6.03	6.17	6.01	5.87	5.71	5.52
.586	6.21	6.24	6.21	6.05	5.81	5.86	5.41
33 420.424	6.13	5.78	6.47	6.00	5.60	5.68	5.52
.438	6.52	5.93	6.26	6.15	5.73	5.90	5.81
.450	6.18	5.95	6.33	6.08	5.70	5.98	5.78
.476	5.45	5.89	6.31	6.09	5.45	5.74	5.72
.487	5.33	5.90	6.44	6.11	5.50	6.03	5.76
.498	5.13	5.96	6.55	6.08	5.64	6.00	5.71
.510	5.05	6.10	6.14	6.24	5.57	6.03	5.74
.523	4.85	—	5.82	6.35	5.69	6.09	5.88

Table 9 (continued)

J. D. 2 400 000 +	92	93	94	96	97	99	100
33 421.385	6.24	6.02	6.40	5.90	5.92	5.46	5.76
.442	6.24	5.70	6.15	6.00	5.54	5.94	5.99
.454	6.62	5.60	6.26	5.97	5.62	5.77	5.88
.465	6.38	5.52	6.30	6.29	5.48	5.78	5.82
.475	5.92	5.52	6.22	6.24	5.69	5.96	5.62
.486	5.60	5.39	6.24	6.00	5.66	5.87	5.62
.497	5.19	5.30	6.28	6.11	5.67	6.04	5.35
.535	4.84	5.47	6.41	—	5.68	5.86	5.32
.548	5.04	—	6.43	6.00	5.66	5.88	5.18
33 422.398	6.32	6.18	6.24	5.97	5.79	5.79	6.02
.431	6.26	6.08	6.47	6.08	5.59	5.78	6.03
.442	6.25	6.25	6.22	6.03	5.65	5.88	—
.452	6.44	6.29	6.39	6.06	5.60	5.95	5.99
.462	6.18	6.28	6.56	6.15	5.37	5.65	5.93
.472	6.46	6.23	6.57	6.15	5.66	5.88	5.91
.483	5.98	6.27	6.35	6.29	5.49	5.95	5.87
.493	5.59	6.10	6.20	6.20	5.47	5.88	6.05
.508	5.30	5.99	6.27	6.17	5.46	5.80	5.85
.520	5.16	6.12	6.65	6.18	5.46	5.89	5.86
33 763.406	5.12	6.03	6.26	5.58	5.53	5.38	5.84
.420	5.00	5.96	6.20	5.66	5.50	5.50	5.84
.442	5.07	6.02	5.90	5.75	5.50	5.54	5.88
.455	5.17	6.20	6.27	5.77	5.58	5.71	5.85
.464	5.32	6.11	6.23	5.80	5.55	5.73	5.95
.483	5.40	6.25	6.25	5.89	5.53	5.87	6.06
.494	5.40	6.13	6.35	5.87	5.61	5.79	5.83
.504	5.59	6.17	6.23	5.99	5.64	5.93	5.87
.514	5.57	6.16	6.23	5.95	5.80	6.12	5.97
.525	5.72	6.13	6.13	5.98	5.82	6.07	5.86
34 118.355	6.30	5.17	5.96	5.06	5.86	5.66	5.26
.372	6.19	5.30	6.40	4.73	5.84	5.36	5.33
.388	5.99	5.17	6.18	4.56	5.71	5.45	5.31
.428	5.19	5.61	6.46	5.15	5.55	5.22	5.41
.443	4.88	5.65	5.98	5.20	5.53	5.46	5.27
.470	4.98	5.69	—	5.36	5.60	5.36	—
.485	5.21	5.89	6.21	5.55	5.59	5.52	5.55
.499	5.16	5.73	6.16	5.52	5.52	5.52	5.79
.513	5.40	5.88	6.26	5.64	5.50	5.60	5.88
.526	5.32	6.00	6.28	5.54	5.45	5.80	5.72
.540	5.62	5.99	6.33	5.90	5.74	5.68	5.58
34 120.471	4.87	6.11	6.30	5.36	5.53	5.65	5.76
.484	5.03	6.00	6.17	5.49	5.49	5.64	5.79
.497	5.07	6.14	6.22	5.51	5.47	5.62	5.48
.510	5.26	6.12	6.28	5.61	5.63	5.70	5.93
.523	5.33	6.02	6.02	5.77	5.67	5.57	5.94
.536	5.39	6.02	6.20	5.72	5.72	5.48	5.72

Table 9 (continued)

J. D. 2 400 000 +	92	93	94	96	97	99	100
34 120.551	5.47	6.18	6.29	5.82	5.82	5.52	5.82
.564	5.63	6.22	6.29	5.86	5.81	5.69	6.05
.579	5.63	6.08	6.12	5.81	5.96	5.52	5.98
34 121.401	6.12	5.39	5.78	4.96	5.65	5.51	5.30
.412	6.04	5.42	5.84	4.98	5.64	5.74	5.40
.422	5.92	5.46	5.92	5.08	5.69	5.82	5.27
.431	5.64	5.52	5.85	5.24	5.54	5.76	5.32
.441	5.38	5.62	6.00	5.26	5.54	5.81	5.29
.484	4.95	5.73	6.20	5.60	5.53	5.86	5.56
.495	5.06	5.77	6.21	5.69	5.55	5.83	5.47
.505	5.21	5.76	6.01	5.56	5.61	5.94	5.56
.517	5.18	5.88	6.18	5.65	5.59	5.88	5.51
.528	5.40	5.80	6.07	5.73	5.64	5.86	5.57
.539	5.40	5.82	—	5.66	5.63	5.82	5.63
.552	5.44	5.72	5.26	5.79	5.59	5.72	5.56
.562	j5.43	5.90	6.27	5.93	5.67	5.63	—
.594	5.66	5.84	5.99	5.81	5.77	5.47	5.55
.605	5.69	6.00	—	—	—	—	—
34 122.404	—	6.08	5.64	5.00	5.77	5.54	—
.416	6.06	6.20	5.74	5.05	5.68	5.52	5.72
.431	5.74	6.20	5.76	5.16	5.80	5.54	5.84
34 126.433	6.08	5.94	6.11	4.94	5.68	5.52	5.42
34 131.415	6.48	—	6.08	5.08	6.14	5.54	5.72
34 487.347	6.30	5.99	5.11	5.99	5.99	5.74	5.74
.367	6.20	6.23	5.36	6.10	5.94	5.62	5.76
.385	6.40	6.40	5.53	6.14	6.00	5.71	5.99
.397	—	—	5.54	6.17	6.14	5.66	5.70
.410	6.09	6.09	5.82	6.05	6.03	5.96	6.03
.428	6.02	—	5.74	5.61	5.96	5.80	5.72
.438	6.20	6.27	5.81	5.12	5.86	5.91	5.84
.449	6.38	6.41	5.93	4.81	5.98	5.83	5.93
.460	—	—	5.95	4.77	5.91	5.60	5.89
.474	—	—	6.02	4.81	5.88	5.60	5.70
.483	—	6.14	6.12	4.90	5.76	5.61	5.83
.494	5.64	6.12	6.18	5.04	5.90	5.53	5.98
.508	5.11	5.75	6.14	5.14	5.64	5.62	5.86
.518	4.98	5.59	5.94	5.12	5.63	5.72	5.92
34 488.530	5.05	6.02	5.79	5.18	5.61	5.79	5.66
.540	5.03	—	5.82	5.34	5.66	5.82	5.80
34 567.388	6.21	—	6.12	4.99	6.00	5.76	5.93
35 223.415	5.99	6.27	6.35	6.12	5.48	5.56	5.87
.428	6.00	6.22	6.34	6.21	5.49	5.58	5.81
.441	6.03	6.12	6.25	6.10	5.54	5.66	6.00
.467	6.04	6.28	6.16	6.02	5.64	5.80	5.46
.490	6.26	6.17	6.19	5.87	5.64	5.76	5.57
.503	6.20	5.95	6.11	5.95	5.93	5.81	5.40

Table 9 (continued)

J. D. 2 400 000 +	92	93	94	96	97	99	100
35 223.517	6.22	5.63	6.35	6.02	6.00	5.83	5.26
.530	6.28	5.60	6.24	6.17	5.94	5.81	5.34
.546	6.17	5.45	6.11	5.98	6.00	5.91	5.24
.573	6.10	5.22	6.26	6.05	6.05	5.85	5.37
35 224.454	6.13	6.13	6.48	6.02	5.61	5.37	5.76
.472	6.18	6.18	6.44	5.75	5.50	5.45	5.70
.485	6.18	6.16	6.32	6.02	5.69	5.72	5.94
.499	6.10	6.19	6.32	6.10	5.73	5.60	5.89
.512	6.39	6.14	6.36	5.70	5.86	5.75	5.78
.524	6.06	5.98	6.32	5.88	5.66	5.54	6.06
.542	6.23	6.23	6.20	5.98	5.92	5.77	5.96
.556	6.16	6.22	6.28	5.90	5.88	5.72	6.05
.569	6.50	6.03	6.18	5.96	5.87	5.85	5.79
.583	6.22	6.26	6.12	5.89	6.00	5.99	5.84
35 227.534	6.07	6.12	6.40	6.09	6.15	6.12	5.88
.547	6.12	6.08	6.12	6.26	5.85	6.14	6.12
.560	6.11	6.32	6.09	6.06	5.90	6.17	5.90
.573	6.23	5.89	—	6.09	6.44	5.78	6.21
.586	6.32	6.38	6.49	5.68	6.12	5.68	5.88
35 598.507	5.76	6.00	6.65	6.11	5.60	5.72	5.40
.524	5.94	6.16	5.99	6.04	5.59	5.67	5.49
.537	5.96	5.92	6.36	5.96	5.43	5.54	5.27
35 600.363	5.04	6.13	6.05	5.71	6.03	5.66	5.50
.378	4.91	5.75	6.05	5.75	6.14	5.33	5.28
.391	5.05	6.16	6.44	6.05	5.93	5.39	5.44
.405	5.00	6.02	6.11	5.94	6.02	5.22	5.16
.421	5.23	6.10	6.23	5.75	6.04	5.36	5.46
.434	5.23	6.06	6.31	5.79	5.86	5.21	5.35
.446	5.55	6.25	6.55	6.25	5.89	5.27	5.50
.501	5.74	—	6.31	6.27	5.44	5.64	5.76
.525	5.79	6.47	6.30	6.07	5.61	5.94	5.50
35 603.369	5.68	6.13	5.54	5.78	5.94	5.44	6.00
.381	5.38	6.27	5.49	5.84	5.96	5.49	6.06
.397	5.05	6.18	5.57	5.97	5.99	5.63	5.91
.408	5.06	6.13	5.73	5.81	5.95	5.60	5.64
.419	5.05	6.20	5.67	5.92	6.04	5.85	5.50
.431	5.16	6.10	5.74	5.91	6.20	5.74	5.49
.446	5.29	6.02	5.70	6.02	5.96	5.63	5.45
.457	5.32	6.17	5.91	6.17	6.04	5.88	5.54
.468	5.51	6.09	5.95	5.95	5.95	5.83	5.43
.491	5.50	6.25	5.96	6.00	5.55	—	5.32
.507	5.67	6.35	6.12	5.98	5.64	5.98	5.38
35 920.444	6.49	5.40	6.48	5.31	5.51	—	5.22
.467	6.50	5.32	6.38	5.40	5.70	5.73	5.32
.487	—	5.74	—	5.75	5.62	5.49	5.82
.504	6.20	5.53	6.09	5.66	5.80	—	5.53

Table 9 (continued)

J. D. 2 400 000 +	92	93	94	96	97	99	100
35 920.547	6.38	5.80	6.23	5.80	6.04	5.56	5.37
.562	6.25	5.80	6.32	5.80	6.13	5.70	5.41
.585	6.22	5.80	6.36	5.92	6.02	5.55	5.40
35 933.415	5.66	6.14	6.14	5.38	5.64	5.60	5.40
.443	6.09	6.15	5.98	5.56	5.59	5.48	5.33
.479	6.23	6.17	6.04	5.74	5.64	5.47	5.43
.503	6.19	5.88	6.29	5.44	5.50	5.27	5.50
.515	6.16	6.13	6.37	6.03	5.62	5.65	5.14
.530	6.22	6.31	6.35	5.63	5.58	5.58	5.78
.543	6.48	6.12	6.37	5.79	5.85	5.36	—
.573	—	5.91	6.29	5.74	5.81	5.56	5.07
.588	—	—	5.81	5.68	5.94	5.59	5.85
.602	—	5.93	—	5.61	5.68	5.59	—
36 991.457	—	5.52	6.07	5.89	5.56	5.53	5.40
.470	6.19	5.85	6.04	6.02	5.43	5.61	5.29
.485	6.03	5.87	—	5.89	5.60	5.90	5.35
37 018.470	5.24	5.47	5.64	6.10	5.89	5.38	6.01
.483	5.37	5.46	5.86	6.01	6.03	5.52	5.82
.496	5.67	5.80	5.93	5.88	6.09	5.44	6.05
.510	5.65	5.70	5.79	5.95	5.90	5.78	5.98
.523	5.70	5.62	5.96	6.02	6.05	5.88	6.04
.537	5.72	5.83	5.95	5.87	—	5.76	5.89
.550	5.69	5.73	5.98	5.85	5.78	5.73	5.94
.563	5.78	5.58	5.81	5.45	5.86	5.80	—
.577	5.85	5.78	6.28	4.87	5.66	5.92	6.08
.609	5.86	5.78	—	4.80	5.63	5.92	5.92
.623	6.06	5.94	6.14	5.05	5.72	—	6.27
.637	5.98	5.98	5.90	5.24	5.60	6.17	5.98
37 057.539	6.40	5.57	6.31	4.74	5.60	5.77	6.05
.552	6.31	5.38	6.19	4.77	5.71	5.57	—
.578	6.25	5.28	5.45	4.95	6.12	5.89	6.12
37 058.529	6.29	6.08	6.19	5.22	5.69	5.40	5.93
.580	6.36	6.40	6.67	5.07	5.97	5.83	6.29
37 757.598	5.66	5.81	—	6.31	5.72	5.85	5.26
37 791.365	4.86	5.74	5.43	5.74	5.64	5.74	5.49
.380	5.02	5.93	5.56	5.76	5.72	5.89	5.72
.394	5.10	5.90	5.51	5.84	5.73	5.79	5.70
.424	5.30	5.99	5.71	5.73	5.71	5.80	5.83
.439	5.42	6.09	5.79	5.98	5.92	5.73	5.86
.454	5.57	6.13	5.85	6.22	5.99	5.72	5.78
.469	5.61	6.10	5.87	6.06	5.98	5.61	5.75
.483	5.71	6.22	5.98	6.19	6.06	5.44	5.90
.497	5.71	6.10	6.01	6.09	6.06	5.51	5.75
.519	5.90	6.19	6.09	6.16	6.07	5.58	5.96
.533	5.82	6.09	6.32	5.96	6.23	5.40	5.68
.549	—	6.18	6.20	6.06	6.04	5.38	5.60
.563	6.12	6.06	6.36	6.12	5.89	5.23	5.43

Table 9 (continued)

J. D. 2 400 000 +	101	102	104	105	106	107	108
28 963.487	4.91	5.60	5.35	5.67	5.30	5.67	6.34
28 991.403	5.48	5.67	5.27	5.63	4.97	5.54	6.15
.416	5.34	5.64	5.58	5.72	5.08	5.58	6.13
.430	5.36	5.71	5.60	5.60	5.00	5.56	6.17
.522	5.33	—	5.69	5.26	4.95	6.12	6.36
.542	5.18	—	5.89	5.19	5.32	6.05	6.28
29 346.376	5.64	5.74	—	5.21	5.93	5.74	6.37
.392	5.64	5.81	—	5.41	6.04	5.41	6.04
29 719.549	5.58	5.85	5.92	5.41	6.16	5.80	6.26
.560	5.59	5.77	5.66	5.30	5.91	6.04	6.24
29 720.546	5.70	5.65	5.96	5.87	5.96	6.02	6.32
.558	5.66	5.60	—	5.60	5.97	5.97	6.07
29 774.405	5.58	5.84	5.16	5.55	5.06	5.58	6.13
.417	5.91	5.76	5.27	5.60	5.06	5.54	6.11
29 775.403	5.15	5.82	5.95	5.43	5.98	5.48	5.95
.415	5.13	5.83	5.78	5.49	5.97	5.59	5.97
.426	5.35	5.92	5.62	5.48	5.92	5.65	5.88
.437	5.40	5.66	5.05	5.51	5.95	5.69	6.10
.447	5.39	5.71	—	5.56	5.66	5.69	6.14
30 052.462	5.97	5.80	4.81	5.50	5.53	6.26	6.31
.474	5.73	5.73	4.97	5.46	5.73	6.27	6.38
.489	5.68	5.84	5.11	5.43	5.71	6.07	6.42
.501	5.71	5.91	5.10	5.45	5.69	6.04	6.22
30 078.418	5.72	5.76	5.99	5.49	6.01	6.05	6.34
.434	5.74	5.63	5.86	5.39	6.01	5.91	6.20
.470	5.64	5.81	5.86	5.62	6.05	5.73	6.17
.483	5.70	5.76	6.02	5.57	6.00	5.62	6.24
.498	5.74	5.70	5.83	5.58	5.98	5.44	5.14
.509	5.93	5.83	5.83	5.63	6.09	5.35	6.22
.521	5.85	5.83	5.89	5.85	5.97	5.62	6.16
.536	5.70	5.83	6.10	5.70	5.94	5.36	6.22
.548	5.62	5.78	5.82	5.80	5.96	5.43	6.34
33 390.497	5.82	5.84	4.66	5.59	5.92	5.38	6.34
.534	5.79	5.83	4.89	5.59	5.59	5.55	6.30
.545	5.88	5.69	4.87	5.39	5.25	5.64	6.22
.558	5.66	5.77	5.11	5.29	5.14	5.66	6.24
.570	5.80	5.78	5.10	5.40	5.13	5.71	6.17
.586	5.92	5.95	5.28	5.39	5.24	5.84	6.34
33 420.424	5.83	5.98	5.92	5.66	5.98	5.49	5.78
.438	5.68	5.90	5.83	5.70	6.07	5.58	5.95
.450	5.60	5.95	6.08	5.53	6.13	5.50	5.89
.476	5.34	5.74	5.91	5.24	6.09	5.45	5.96
.487	5.36	5.76	6.01	5.43	6.05	5.70	6.05
.498	5.25	5.79	5.81	5.41	6.14	5.45	6.10
.510	5.35	5.74	5.92	5.38	6.08	5.45	6.08
.523	5.07	—	5.99	5.18	5.88	5.54	—

Table 9 (continued)

J. D. 2 400 000 +	101	102	104	105	106	107	108
33 421.385	5.89	5.74	5.26	5.26	5.76	5.29	5.31
.442	5.81	5.74	5.56	5.44	5.90	5.49	5.73
.454	5.64	5.70	5.79	5.49	5.80	5.54	5.73
.465	5.48	5.68	—	5.60	5.84	5.52	5.82
.475	5.64	5.77	—	5.52	6.08	5.79	5.83
.486	5.70	5.76	—	5.76	6.00	5.80	5.89
.497	5.72	6.04	5.51	5.65	6.21	5.96	5.98
.535	5.59	5.90	—	5.63	5.98	6.04	5.90
.548	5.56	5.91	5.60	—	5.98	5.86	5.99
33 422.398	5.62	5.97	4.88	5.69	5.57	5.69	5.15
.431	5.55	5.99	4.75	5.85	5.85	5.83	5.47
.442	5.54	5.73	5.05	5.54	5.70	5.99	5.54
.452	5.46	6.02	5.06	5.54	5.70	6.02	5.60
.462	5.34	5.74	5.20	5.57	5.71	6.13	5.62
.472	5.45	5.83	5.28	5.39	5.77	5.91	5.60
.483	5.25	5.95	5.08	5.43	5.80	5.87	5.60
.493	5.47	5.92	5.42	5.30	5.85	6.05	5.88
.508	5.44	5.82	5.16	5.33	5.85	6.03	5.80
.520	5.46	5.76	5.33	5.27	5.76	5.91	5.89
33 763.406	5.76	5.84	5.72	5.75	5.84	5.98	5.92
.420	5.72	5.75	—	5.63	5.91	5.84	5.93
.442	6.04	5.85	6.01	5.45	5.95	5.54	6.04
.455	5.92	5.81	5.96	5.44	6.03	5.44	6.14
.464	5.99	5.84	5.95	5.39	6.03	5.44	6.15
.483	5.90	5.80	6.03	5.30	6.17	5.46	—
.494	5.72	5.81	5.66	5.31	6.02	5.33	6.19
.504	5.76	5.79	5.87	5.35	6.08	5.40	6.18
.514	5.90	5.85	6.27	5.33	6.02	5.44	6.38
.525	5.80	5.70	5.91	5.39	6.02	5.36	6.28
34 118.355	—	5.84	—	5.66	5.58	5.88	6.24
.372	—	—	—	5.77	5.53	5.98	6.10
.388	—	5.93	5.36	5.56	5.80	5.93	6.38
.428	5.01	5.69	5.55	5.61	5.61	5.99	6.18
.443	5.27	5.80	5.68	5.76	5.74	6.14	6.27
.470	5.36	—	5.66	5.69	5.90	6.18	6.34
.485	5.21	5.69	5.74	5.59	5.71	5.98	6.24
.499	5.09	—	—	5.52	5.85	6.01	6.45
.513	5.33	6.10	5.99	5.50	5.96	5.67	6.42
.526	5.26	—	—	5.42	5.91	5.68	5.95
.540	5.43	5.68	5.62	5.22	5.80	5.33	6.17
34 120.471	5.39	—	—	5.67	5.31	5.48	6.17
.484	5.35	—	—	5.66	5.33	5.62	6.24
.497	5.51	5.67	—	5.84	5.39	5.73	6.18
.510	5.47	5.82	—	5.76	5.42	5.73	6.06
.523	5.46	5.77	—	5.55	5.52	5.90	6.41
.536	5.35	—	4.64	5.48	5.39	5.95	6.13

Table 9 (continued)

J. D. 2 400 000 +	101	102	104	105	106	107	108
34 120.551	5.38	5.66	4.60	5.23	5.47	6.03	6.27
.564	5.49	6.00	4.74	5.43	5.73	6.11	6.29
.579	—	5.75	5.19	5.34	5.73	6.22	6.43
34 121.401	5.56	—	—	5.44	5.87	5.68	5.84
.412	5.79	—	—	5.34	6.04	5.64	6.14
.422	5.72	—	6.08	5.30	6.10	5.72	5.90
.431	5.83	5.78	—	5.30	5.92	5.78	5.96
.441	5.70	6.02	6.00	5.38	6.14	5.76	6.00
.484	5.70	—	6.19	5.40	5.82	5.95	6.09
.495	5.79	—	6.01	5.30	5.83	5.96	6.13
.505	5.69	—	5.83	5.48	5.80	5.97	6.07
.517	5.80	5.80	—	5.51	5.68	6.00	6.22
.528	5.76	—	—	5.42	5.54	5.94	6.16
.539	—	—	—	5.63	5.38	6.14	6.07
.552	—	—	—	5.63	5.32	6.03	6.09
.562	—	—	—	5.58	5.24	5.92	—
.594	—	—	—	5.72	5.30	5.77	6.53
.605	—	—	—	—	—	5.71	—
34 122.404	—	—	—	5.64	—	5.92	5.76
.416	5.38	—	—	5.56	5.78	5.96	5.92
.431	5.52	—	—	5.61	5.84	6.19	5.91
34 126.433	5.63	—	5.55	5.50	5.68	6.08	4.94
34 131.415	5.36	—	4.96	5.68	5.06	5.96	6.42
34 487.347	5.58	5.78	—	5.80	5.78	5.78	6.22
.367	5.20	5.84	—	5.76	5.82	5.96	6.16
.385	5.41	5.86	—	5.74	6.14	5.86	6.14
.397	5.33	5.66	—	5.56	5.86	5.79	6.12
.410	5.38	6.09	—	5.70	6.26	5.96	6.35
.428	—	5.76	—	5.39	5.95	5.90	6.20
.438	5.18	5.82	—	5.30	5.84	5.93	6.27
449	5.19	5.85	—	5.32	6.09	6.15	6.23
.460	5.20	5.89	—	5.37	6.28	—	6.16
.474	5.37	5.68	—	5.32	5.88	6.08	6.38
.483	5.18	5.70	—	5.25	5.98	5.76	—
494	5.33	5.84	—	5.44	—	5.73	6.26
.508	5.34	5.84	—	5.27	—	5.50	5.89
.518	5.30	5.92	—	5.49	5.98	5.41	6.00
34 488.530	—	5.75	—	5.75	6.12	5.59	6.44
.540	5.82	5.71	—	5.56	—	5.61	6.19
34 567.388	5.56	5.80	4.74	5.65	5.89	5.89	6.21
35 223.415	5.16	5.62	5.16	5.67	5.95	5.51	5.60
.428	5.07	5.64	—	5.60	5.97	5.56	5.77
.441	5.45	5.89	5.37	5.52	6.25	5.74	5.70
.467	5.27	5.78	5.34	5.32	5.84	5.78	5.78
.490	5.34	5.80	—	5.32	5.57	5.94	5.84
.503	5.44	5.87	5.87	5.35	5.37	5.95	5.97

Table 9 (continued)

J. D. 2 400 000 +	101	102	104	105	106	107	108
35 223.517	5.39	5.83	5.58	5.31	5.29	—	6.16
.530	5.29	5.82	5.34	5.34	5.26	5.97	5.99
.546	5.40	5.77	—	5.38	5.26	6.10	6.06
.573	5.40	—	5.69	5.43	5.32	6.05	6.35
35 224.454	5.42	5.60	5.06	5.51	5.88	5.95	5.46
.472	5.68	5.66	4.72	5.54	5.93	6.06	5.95
.485	5.74	5.82	4.62	5.69	6.04	6.10	5.78
.499	5.76	5.77	4.69	5.70	6.04	6.08	5.84
.512	5.75	5.82	4.76	5.70	6.10	5.88	5.91
.524	5.74	5.79	4.98	5.74	6.16	5.86	5.74
.542	5.67	5.79	5.30	5.72	—	5.72	6.16
.556	5.66	5.83	5.04	5.68	5.90	5.43	6.10
.569	5.65	5.79	—	5.71	5.65	5.56	5.82
.583	5.72	5.89	5.35	5.59	5.57	5.54	6.12
35 227.534	5.69	6.42	5.75	5.32	5.70	5.88	5.26
.547	5.78	6.12	5.70	5.26	6.16	6.30	5.59
.560	5.90	5.90	6.22	5.54	5.72	5.90	5.52
.573	5.94	5.80	—	5.35	5.78	5.80	5.58
.586	6.16	—	—	5.32	5.68	5.98	5.51
35 598.507	5.92	5.72	5.51	5.44	5.64	5.51	5.11
.524	5.92	6.02	5.52	5.81	5.92	5.36	5.25
.537	5.77	5.96	5.77	5.71	5.89	5.43	5.39
35 600.363	5.94	5.80	—	5.88	6.30	5.38	6.41
.378	5.52	5.75	—	5.50	6.24	5.38	6.27
.391	5.69	5.89	5.99	5.67	5.93	5.46	6.15
.405	5.62	5.90	—	5.39	5.82	5.48	6.05
.421	6.00	5.86	5.88	5.33	6.00	5.46	6.27
.434	6.01	5.60	—	5.44	5.93	5.56	6.21
.446	5.98	5.70	—	5.36	5.83	5.64	6.12
.501	5.69	5.76	—	—	5.53	5.83	6.07
.525	5.73	5.92	—	5.45	5.36	6.03	5.70
35 603.369	—	5.59	—	5.32	5.61	5.88	5.86
.381	5.46	5.90	—	5.52	6.10	6.00	6.10
.397	5.54	5.82	—	5.44	5.71	5.91	6.18
.408	5.22	5.73	—	5.52	5.71	5.82	6.10
.419	5.28	5.93	—	5.56	5.71	5.56	6.29
.431	5.46	5.87	—	5.73	5.73	5.65	6.24
.446	5.86	5.86	5.37	5.75	5.75	5.37	6.27
.457	5.54	5.59	4.76	5.80	5.75	5.42	6.24
.468	5.57	5.70	4.77	5.59	5.78	5.43	6.43
.491	5.55	5.62	4.96	5.71	5.75	5.35	6.02
.507	5.50	5.84	4.88	5.70	5.87	5.51	6.14
35 920.444	6.18	—	5.07	5.11	5.80	5.98	6.40
.467	6.14	—	4.95	5.28	5.80	5.90	6.20
.487	5.96	—	5.49	5.49	5.92	5.67	5.95
.504	6.12	—	5.11	5.50	5.93	5.42	6.14

Table 9 (continued)

J. D. 2 400 000 +	101	102	104	105	106	107	108
35 920.547	6.10	—	5.48	5.52	5.52	5.29	6.27
.562	6.40	—	5.66	5.58	5.38	5.25	6.56
.585	6.28	—	5.55	5.55	5.05	5.43	6.38
35 933.415	5.96	—	6.16	5.34	5.77	6.12	6.14
.443	6.01	—	4.94	5.20	5.70	6.01	6.37
.479	5.84	—	4.58	5.36	5.84	5.39	6.06
.503	—	—	4.70	5.44	6.14	5.36	6.10
.515	—	—	4.72	5.57	6.01	5.44	6.03
.530	5.66	—	4.96	5.78	6.00	5.49	6.57
.543	—	—	—	5.68	5.60	5.30	—
.573	5.58	—	5.18	5.64	6.10	5.64	6.17
.588	—	—	—	5.36	5.96	5.58	5.87
.602	—	—	—	5.49	5.49	5.68	5.49
36 991.457	5.66	—	5.30	5.30	5.56	—	6.07
.470	5.81	—	5.66	5.39	5.36	5.69	6.52
.485	5.43	—	6.03	5.71	5.35	5.93	6.28
37 018.470	5.93	—	5.81	5.39	5.90	6.03	6.39
.483	5.98	—	5.94	5.46	5.82	5.74	6.32
.496	5.48	—	5.72	5.40	5.76	5.42	6.09
.510	5.82	—	6.10	5.54	5.76	5.52	6.19
.523	5.20	—	5.93	5.45	6.04	5.42	6.22
.537	5.73	—	5.80	5.49	5.69	5.41	5.39
.550	5.27	—	5.98	5.69	5.90	5.35	5.37
.563	5.20	—	5.51	—	6.00	5.52	5.06
.577	5.42	—	4.84	5.58	5.87	5.43	5.08
.609	5.69	—	—	5.74	6.22	5.66	5.20
.623	5.49	—	4.95	5.82	6.06	5.89	5.35
.637	5.74	—	5.00	5.71	6.14	5.71	5.52
37 057.539	6.23	—	5.44	5.37	5.69	5.57	5.10
.552	6.04	—	5.71	5.50	5.14	5.71	5.09
.578	6.29	—	5.55	5.44	5.00	5.78	5.07
37 058.529	5.69	—	5.20	5.50	6.01	5.93	6.08
.580	5.97	—	5.26	5.73	—	6.06	5.14
37 757.598	—	—	—	5.52	5.78	6.07	5.85
37 791.365	6.14	—	6.03	5.20	4.80	6.03	5.81
.380	6.16	5.76	5.40	5.40	5.02	5.87	5.89
.394	5.89	5.68	5.09	5.41	5.27	5.56	5.84
.424	5.79	5.81	4.89	5.66	5.38	5.45	6.02
.439	5.78	5.72	5.10	5.74	5.53	5.42	6.20
.454	5.87	5.60	4.69	5.57	5.44	5.25	6.06
.469	5.90	5.75	5.04	5.62	5.58	5.53	6.12
.483	5.77	5.86	5.16	5.65	5.69	5.40	6.31
.497	5.88	5.66	5.05	5.63	5.63	5.57	6.30
.519	6.04	5.87	5.32	5.74	5.85	5.64	6.28
.533	5.93	5.71	5.60	5.68	5.90	5.71	6.20
.549	6.01	5.81	5.81	5.60	5.95	5.66	6.16
.563	5.89	5.92	5.57	5.57	6.03	5.92	6.36

Table 9 (continued)

J. D. 2 400 000 +	109	110	113	114	115	116	117
28 963.487	4.86	5.80	6.13	5.22	4.89	5.84	6.20
28 991.403	5.27	5.42	4.71	6.04	6.06	5.51	5.78
.416	5.00	5.39	5.08	6.02	6.24	5.72	6.11
.430	5.18	5.13	4.92	6.09	6.08	5.63	6.14
.522	—	—	5.66	5.72	6.20	6.24	—
.542	—	—	5.76	5.66	6.25	6.12	5.56
29 346.376	4.76	5.58	4.72	6.41	6.30	—	5.35
.392	5.41	5.54	5.15	6.01	5.29	5.95	5.69
29 719.549	5.04	5.90	6.14	5.92	6.37	6.24	6.11
.560	5.19	5.84	6.00	5.82	6.27	6.18	6.14
29 720.546	4.69	5.89	6.11	6.09	6.20	6.34	6.26
.558	4.63	5.78	6.07	6.13	6.11	6.42	6.21
29 774.405	5.33	5.52	5.90	6.21	6.27	5.49	5.30
.417	5.06	5.35	5.98	6.38	6.06	5.54	5.18
29 775.403	5.56	5.21	5.77	5.95	6.06	5.15	5.95
.415	5.47	5.13	5.89	6.04	6.01	5.33	6.17
.426	—	5.28	5.92	5.94	6.30	5.25	6.15
.437	5.59	5.30	5.98	6.00	6.03	5.42	6.07
.447	5.58	5.42	5.83	6.10	6.27	5.66	6.16
30 052.462	5.53	5.85	5.90	6.31	6.16	5.77	5.47
.474	5.88	5.79	5.97	6.09	6.14	5.85	5.23
.489	5.94	6.09	5.87	6.07	6.15	6.02	5.20
.501	5.62	5.91	6.10	5.69	6.29	5.87	5.32
30 078.418	5.38	5.06	5.83	5.90	6.04	6.45	5.74
.434	5.49	5.11	5.11	5.94	5.30	6.28	5.68
.470	5.26	5.35	4.96	5.97	4.96	6.03	5.79
.483	5.48	5.31	4.99	6.12	5.22	6.27	5.74
.498	5.41	5.41	5.20	6.10	5.30	6.12	5.92
.509	5.57	5.54	5.23	6.01	5.33	6.29	5.90
.521	5.36	5.53	5.45	6.11	5.44	6.28	6.03
.536	5.36	5.56	5.46	6.04	5.60	6.20	5.98
.548	5.49	5.65	5.69	6.07	5.65	6.20	5.94
33 390.497	5.77	5.28	5.24	5.72	6.29	5.69	6.07
.534	5.68	5.47	5.53	6.12	6.48	5.92	6.05
.545	5.48	5.48	5.54	—	6.39	6.04	6.22
.558	5.48	5.38	5.66	6.11	6.35	6.11	6.20
.570	5.55	5.69	5.69	6.08	6.02	6.10	5.87
.586	5.64	5.66	5.81	6.21	5.39	6.21	6.21
33 420.424	5.63	5.12	5.98	6.03	5.20	6.16	5.95
.438	5.73	5.31	6.24	6.07	5.30	6.34	5.95
.450	5.86	5.52	6.18	6.34	5.44	5.99	5.95
.476	5.56	5.36	6.30	6.07	5.43	6.31	6.09
.487	5.66	5.39	—	6.05	5.65	6.40	6.05
.498	5.86	5.39	6.57	6.10	5.70	6.34	6.10
.510	5.59	5.40	6.22	6.14	5.90	6.34	6.12
.523	5.61	5.54	—	—	5.84	—	—

Table 9 (continued)

J. D. 2 400 000 +	109	110	113	114	115	116	117
33 421.385	5.62	5.78	5.76	5.36	5.54	5.74	5.22
.442	5.46	4.94	6.18	5.66	5.17	5.92	5.31
.454	5.51	4.89	6.24	5.77	5.18	6.06	5.37
.465	5.36	4.73	6.23	5.76	5.29	6.13	5.40
.475	5.23	4.87	6.23	5.69	5.37	6.12	5.52
.486	5.14	4.83	6.22	5.76	5.46	6.02	5.41
.497	5.50	5.21	6.09	5.80	5.49	6.15	5.60
.535	5.56	5.21	6.13	5.80	5.72	6.41	5.72
.548	—	5.23	6.15	5.91	5.68	6.37	5.70
33 422.398	5.62	5.89	—	6.34	6.13	5.69	6.12
.431	5.59	6.05	5.99	6.05	5.12	5.88	6.20
.442	5.63	6.10	5.91	6.08	5.04	5.86	6.18
.452	5.43	5.90	5.99	6.16	5.00	5.80	6.29
.462	5.62	5.87	6.25	5.89	—	5.93	6.15
.472	5.57	5.63	6.35	5.74	5.06	5.91	6.38
.483	5.83	5.83	6.24	5.74	5.16	6.27	6.27
.493	5.30	5.51	6.35	5.82	5.52	6.10	6.20
.508	5.46	5.00	6.27	5.33	5.49	6.20	6.27
.520	5.20	4.93	6.62	5.16	5.50	6.12	6.45
33 763.406	4.78	5.80	4.87	5.88	5.75	6.20	6.00
.420	4.89	—	5.00	5.94	5.78	6.28	6.05
.442	5.05	—	5.12	5.95	5.86	6.20	5.88
.455	5.22	5.85	5.25	6.01	5.97	6.27	5.98
.464	5.26	5.71	5.41	5.99	5.88	6.23	6.03
.483	5.16	5.44	5.49	6.06	6.03	6.22	6.08
.494	5.24	5.45	5.55	6.02	6.12	6.35	5.96
.504	5.30	5.53	5.81	6.02	6.10	6.23	6.18
.514	5.39	5.44	5.63	6.12	6.24	6.30	6.04
.525	—	5.51	5.80	5.96	6.16	6.40	6.09
34 118.355	—	—	6.13	5.66	—	5.29	5.96
.372	—	—	5.98	5.60	6.06	5.36	6.02
.388	—	—	4.83	5.71	6.35	5.48	5.99
.428	4.40	4.98	4.98	5.61	6.22	5.58	6.08
.443	4.72	—	5.12	5.88	6.33	5.74	6.04
.470	4.66	5.08	5.24	6.12	—	5.94	6.06
.485	4.82	5.21	5.55	5.69	6.27	5.84	6.21
.499	4.92	5.16	5.55	6.09	6.18	6.09	6.28
.513	4.80	5.19	5.67	5.96	5.66	6.42	6.02
.526	5.07	5.60	6.06	—	5.19	6.14	5.78
.540	5.08	5.68	5.99	5.86	4.70	6.14	5.80
34 120.471	—	—	4.99	6.05	6.30	5.70	5.58
.484	—	—	5.16	6.26	6.23	5.62	5.60
.497	—	5.51	5.16	6.14	6.53	5.78	5.69
.510	5.65	5.70	5.35	6.28	6.40	5.85	5.63
.523	5.44	5.46	5.44	6.31	6.28	5.96	5.69
.536	4.84	5.19	5.54	6.18	6.44	5.98	5.62

Table 9 (continued)

J. D. 2 400 000 +	109	110	113	114	115	116	117
34 120.551	4.74	5.20	5.47	6.27	6.25	5.84	5.80
.564	4.49	5.15	5.75	6.27	5.89	6.13	5.78
.579	4.52	4.88	5.55	6.38	5.27	6.00	6.02
34 121.401	—	—	6.20	5.65	6.15	4.92	6.03
.412	—	—	6.40	5.91	6.27	4.88	6.08
.422	—	—	6.22	5.95	6.32	5.02	6.04
.431	5.76	—	6.15	5.92	6.32	5.09	6.10
.441	5.70	5.79	6.22	5.79	6.12	5.14	6.08
.484	5.59	5.59	—	5.59	6.38	5.53	6.02
.495	5.47	5.83	5.10	5.98	6.50	5.61	6.15
.505	5.51	5.63	5.13	6.04	6.30	5.67	5.98
.517	5.51	—	5.14	6.12	6.20	5.88	6.02
.528	5.71	—	5.30	6.08	6.32	5.80	5.89
.539	—	—	5.22	6.11	6.33	5.75	5.82
.552	—	—	5.44	6.19	6.26	5.90	5.72
.562	—	—	5.58	—	6.16	5.86	5.63
.594	—	—	5.44	6.20	5.86	6.04	5.28
.605	—	—	5.59	—	5.45	—	4.96
34 122.404	—	—	6.30	6.00	—	5.78	5.97
.416	—	—	6.29	5.80	6.37	5.56	5.86
.431	—	—	6.20	5.68	6.27	4.90	5.98
34 126.433	4.65	5.42	6.47	6.80	6.10	6.08	5.52
34 131.415	—	5.44	6.10	5.60	5.48	6.26	5.96
34 487.347	4.89	5.69	5.65	5.97	6.00	6.40	5.60
.367	—	—	5.78	5.92	6.16	6.08	5.64
.385	4.89	5.66	5.78	5.89	6.21	6.27	5.53
.397	4.98	5.80	5.79	5.96	6.18	6.01	—
.410	4.93	5.67	6.05	6.07	6.40	5.62	5.84
.428	4.90	5.72	6.06	6.40	6.20	5.10	—
.438	5.06	5.80	5.82	5.93	—	4.97	5.66
.449	5.19	6.00	6.13	5.83	6.40	4.98	5.85
.460	5.13	5.84	6.22	6.10	6.25	4.96	5.84
.474	5.23	5.78	6.15	5.85	6.30	5.14	—
.483	5.16	5.83	6.18	6.06	6.27	5.14	—
.494	—	5.84	—	6.21	6.32	5.23	—
.508	5.27	5.75	6.24	5.96	—	5.37	—
.518	5.43	5.85	—	5.95	—	5.54	—
34 488.530	5.13	—	6.11	6.12	6.33	5.42	5.39
.540	5.06	5.98	6.20	6.04	6.27	5.44	5.48
34 567.388	5.70	—	5.74	6.00	6.21	5.86	5.93
35 223.415	5.39	5.43	5.04	6.10	5.85	6.50	6.35
.428	5.36	5.56	4.93	6.13	5.93	6.47	6.48
.441	5.59	5.52	5.04	5.60	5.93	6.40	6.21
.467	5.46	5.57	5.19	5.24	6.07	6.22	6.22
.490	5.51	—	5.43	5.17	6.15	6.33	6.01
.503	5.45	5.52	5.60	5.23	6.22	6.24	5.95

Table 9 (continued)

J. D. 2 400 000 +	109	110	113	114	115	116	117
35 223.517	5.43	5.72	5.63	5.43	6.21	6.54	5.83
.530	—	—	5.65	5.47	6.25	6.11	5.45
.546	—	—	5.71	5.51	6.34	6.36	5.22
.573	—	—	5.78	5.69	6.40	6.31	5.03
35 224.454	5.12	5.24	4.90	6.05	5.92	6.30	6.10
.472	5.30	5.36	4.97	6.36	5.90	6.53	6.06
.485	5.62	5.56	5.21	6.22	6.02	6.35	6.26
.499	—	5.38	5.14	6.26	6.05	6.46	5.92
.512	5.45	5.59	5.32	6.14	6.00	6.32	6.26
.524	5.60	5.52	5.30	6.06	6.07	6.39	6.00
.542	—	5.50	5.39	6.19	6.04	6.24	6.30
.556	—	5.46	5.66	6.05	6.20	6.48	6.24
.569	—	5.90	5.79	6.22	6.28	—	6.12
.583	—	5.96	5.82	6.34	6.14	6.44	6.22
35 227.534	5.54	5.24	4.97	5.88	5.68	6.57	6.07
.547	5.61	5.12	5.07	5.95	5.87	6.56	6.24
.560	5.70	5.24	5.21	6.06	—	—	6.55
.573	5.58	5.18	5.41	6.13	5.86	6.07	5.89
.586	5.81	5.24	5.58	6.51	5.99	6.25	6.21
35 598.507	4.92	4.98	5.49	6.09	5.87	5.60	5.88
.524	4.90	5.13	5.48	5.86	5.12	5.86	6.02
.537	4.84	5.24	5.39	6.00	4.92	5.92	5.92
35 600.363	5.57	5.61	6.30	6.01	6.30	6.24	6.11
.378	5.72	5.94	6.27	6.14	6.37	6.41	6.27
.391	5.60	5.82	6.16	5.93	6.09	6.18	6.32
.405	5.66	6.16	6.03	6.03	6.16	6.16	6.02
.421	5.62	5.88	6.38	6.04	6.30	6.10	6.25
.434	5.39	5.75	6.23	6.21	6.32	5.64	6.08
.446	5.60	5.72	6.08	5.89	6.07	5.19	6.38
.501	5.69	5.95	4.89	6.38	6.33	5.20	6.19
.525	5.52	5.66	5.28	6.36	6.33	5.36	6.09
35 603.369	—	—	6.24	6.12	6.14	6.27	6.05
.381	4.97	5.17	6.18	6.16	6.20	6.18	6.32
.397	5.26	5.24	6.10	6.05	6.19	5.92	6.20
.408	5.37	5.37	6.11	6.21	6.20	6.08	6.02
.419	5.28	5.41	6.44	6.00	6.39	6.26	6.08
.431	5.46	5.58	6.30	6.33	6.18	6.28	6.04
.446	5.35	5.55	6.20	6.20	6.24	6.27	6.24
.457	5.29	5.54	6.16	5.95	6.32	6.29	6.35
.468	5.26	5.57	6.09	6.11	6.37	6.18	6.09
.491	5.55	5.52	6.14	5.91	6.44	6.58	5.98
.507	5.72	5.84	6.24	6.18	6.24	6.04	6.20
35 920.444	4.80	5.82	6.28	5.20	4.87	6.29	6.12
.467	4.82	5.46	6.30	5.32	5.28	6.22	6.16
.487	4.52	5.46	6.14	5.53	5.62	—	—
.504	4.84	5.50	6.03	5.47	5.62	6.18	6.02

Table 9 (continued)

J. D. 2 400 000 +	109	110	113	114	115	116	117
35 920.547	5.06	6.04	6.23	5.49	5.56	6.32	6.13
.562	4.20	5.74	6.19	5.76	5.76	6.32	6.16
.585	4.80	6.00	5.12	5.92	5.95	6.32	5.95
35 933.415	5.38	6.19	5.22	6.24	5.88	6.24	5.52
.443	5.14	5.82	5.03	6.03	5.86	6.18	5.86
.479	5.29	5.67	5.36	6.32	6.15	6.16	5.77
.503	—	—	5.27	6.23	6.08	6.29	5.64
.515	—	—	5.60	5.91	5.91	5.50	6.03
.530	4.92	4.82	5.49	5.81	6.33	5.08	5.78
.543	—	—	5.96	5.87	—	4.88	5.85
.573	5.20	4.97	5.76	5.48	6.05	5.08	5.89
.588	—	—	5.72	5.10	—	5.28	—
.602	—	—	5.91	5.29	—	5.36	—
36 991.457	4.76	5.22	6.16	6.00	6.23	5.31	5.08
.470	4.90	5.47	6.36	5.81	5.96	4.91	5.18
.485	4.61	—	6.04	6.09	6.10	4.84	5.20
37 018.470	5.88	5.77	5.01	5.20	5.15	6.05	5.70
.483	6.02	5.64	5.00	5.33	5.07	6.16	5.34
.496	5.58	—	5.16	5.40	5.20	6.29	5.67
.510	5.97	—	5.28	5.43	5.47	6.16	5.38
.523	5.34	5.80	5.45	5.66	5.62	6.07	5.25
.537	5.36	5.90	5.67	5.53	—	6.46	5.37
.550	5.40	5.74	5.59	5.64	5.56	6.11	5.38
.563	5.66	5.58	5.59	5.88	—	6.60	5.69
.577	5.51	5.56	5.72	5.68	5.83	6.52	5.59
.609	5.69	5.38	5.80	5.84	5.81	6.38	5.66
.623	5.59	—	5.99	5.99	—	6.19	5.80
.637	5.96	5.37	6.22	5.71	5.97	6.56	5.87
37 057.539	6.05	5.88	5.69	6.19	5.37	5.84	5.20
.552	5.68	—	5.67	6.34	5.50	6.06	5.27
.578	5.95	—	6.04	6.23	5.78	6.01	5.28
37 058.529	6.01	5.81	5.50	5.40	5.09	5.69	6.12
.580	5.97	6.11	—	5.73	5.50	5.83	6.06
37 757.598	—	—	6.05	6.21	—	5.44	5.98
37 791.365	4.75	6.32	5.96	5.06	6.21	6.35	5.37
.380	4.62	6.07	6.42	5.52	6.23	6.13	5.52
.394	5.27	5.75	6.08	5.41	6.25	6.24	5.42
.424	5.40	6.06	6.09	5.70	6.24	6.29	5.48
.439	5.78	5.89	6.16	5.74	6.40	6.34	5.71
.454	5.64	6.10	6.19	5.81	6.56	6.13	5.72
.469	5.59	6.06	6.33	5.71	6.23	5.45	5.71
.483	5.40	—	6.35	5.86	6.31	5.16	5.76
.497	5.62	5.79	6.28	5.91	6.60	4.84	5.76
.519	5.81	5.85	5.67	5.98	6.37	5.05	5.85
.533	5.50	5.68	5.11	6.04	6.18	5.19	5.90
.549	5.62	5.53	4.89	5.95	5.40	5.25	5.90
.563	5.70	5.43	4.98	6.12	5.12	5.33	5.92

Table 9 (continued)

J. D. 2 400 000 +	118	119	120	121	123	124	125
28 963.487	4.80	6.10	5.67	4.81	5.49	5.67	5.42
28 991.403	5.81	6.07	5.81	5.27	6.07	5.81	5.67
.416	5.28	6.15	5.91	4.96	6.02	5.78	5.60
.430	4.77	6.06	6.04	4.77	5.99	5.84	5.51
.522	5.50	6.05	6.13	—	6.29	5.75	5.40
.542	5.43	6.28	6.15	—	6.28	5.82	5.41
29 346.376	6.18	5.33	5.55	5.21	—	5.63	5.91
.392	6.36	5.64	5.54	5.39	5.69	5.85	6.01
29 719.549	5.11	5.31	5.52	5.56	5.58	5.70	5.83
.560	5.16	5.13	5.50	5.26	5.91	5.77	5.95
29 720.546	4.96	6.09	6.02	5.18	5.42	5.85	5.57
.558	5.00	6.07	5.97	5.21	5.39	5.83	5.57
29 774.405	6.47	6.13	6.03	5.19	6.36	5.61	5.49
.417	6.40	5.98	6.27	5.35	6.10	5.60	5.60
29 775.403	6.38	6.14	5.81	5.23	6.16	5.95	5.53
.415	6.39	6.26	5.83	5.13	6.21	5.94	5.47
.426	5.99	6.08	5.88	5.35	6.24	5.81	5.57
.437	5.71	6.02	5.88	5.45	6.34	5.93	5.54
.447	5.39	6.18	5.90	5.18	6.14	5.90	5.47
30 052.462	6.66	5.26	5.72	5.64	6.29	5.83	5.55
.474	6.21	5.18	5.65	5.43	6.09	5.97	5.46
.489	6.11	4.92	5.71	5.32	—	5.74	5.48
.501	6.43	4.98	5.80	5.38	6.35	6.08	5.51
30 078.418	6.47	5.26	6.12	5.49	5.69	5.61	5.43
.434	6.06	5.27	5.96	5.30	5.55	5.68	5.46
.470	6.13	5.75	5.91	5.46	5.73	5.75	5.73
.483	6.08	5.31	5.96	5.52	5.94	5.67	5.76
.498	6.02	5.70	6.01	5.49	5.87	5.74	5.79
.509	6.39	5.77	6.11	—	6.01	5.74	5.88
.521	6.26	5.83	6.01	5.64	5.91	5.81	5.93
.536	6.22	5.86	5.95	5.31	6.00	5.65	5.98
.548	6.20	5.91	5.96	5.41	6.09	5.82	5.89
33 390.497	4.95	5.57	6.07	5.05	5.72	5.49	5.53
.534	5.25	5.92	6.05	4.60	5.92	5.63	5.47
.545	5.33	5.95	6.12	4.77	6.04	5.61	5.51
.558	5.40	5.89	5.95	4.83	6.20	5.55	5.48
.570	5.60	6.01	6.08	4.85	5.89	5.69	5.64
.586	5.63	6.21	6.05	5.21	6.37	5.76	5.81
33 420.424	5.37	5.03	6.00	4.94	5.49	5.98	6.23
.438	5.19	5.40	5.98	4.89	5.46	5.85	6.05
.450	4.83	5.29	6.01	4.94	5.62	5.70	6.01
.476	5.02	5.37	5.96	5.24	5.80	5.51	6.01
.487	5.19	5.70	6.05	5.13	5.82	5.64	5.86
.498	5.28	5.59	5.81	5.07	6.06	5.73	5.81
.510	5.38	5.59	6.16	5.16	6.22	5.59	5.79
.523	5.36	5.61	6.15	5.07	—	5.61	5.54

Table 9 (continued)

J. D. 2 400 000 +	118	119	120	121	123	124	125
33 421.385	6.34	5.69	5.66	5.39	6.24	5.50	5.62
.442	5.01	4.89	5.66	5.40	5.08	5.83	5.87
.454	4.97	4.97	5.49	5.30	5.05	5.75	6.00
.465	4.92	5.01	5.48	5.10	5.21	5.78	5.88
.475	5.07	5.16	5.64	5.05	5.34	5.72	5.96
.486	5.19	5.24	—	5.03	5.27	5.78	6.20
.497	5.17	5.30	5.53	5.01	5.47	5.60	5.98
.535	5.59	5.44	5.63	5.06	5.56	5.80	6.10
.548	5.58	5.31	5.66	4.83	5.66	5.66	5.88
33 422.398	6.34	6.07	5.99	5.54	6.34	6.02	5.79
.431	5.17	5.47	5.88	5.64	6.29	5.85	5.91
.442	4.96	5.32	5.88	5.60	6.30	5.81	5.88
.452	5.00	5.06	5.99	5.23	6.23	5.92	5.95
.462	5.10	4.82	5.99	5.50	6.15	5.89	5.65
.472	5.16	4.94	5.96	5.66	6.54	5.93	5.69
.483	5.19	5.02	6.27	5.32	6.21	5.87	5.95
.493	5.27	5.05	6.13	5.47	5.98	5.90	5.76
.508	5.33	5.11	6.06	5.21	5.66	5.94	5.74
.520	5.69	5.08	6.05	5.24	5.36	5.89	6.00
33 763.406	6.26	6.12	5.65	5.61	5.82	5.91	5.48
.420	6.22	6.04	5.72	5.72	5.66	5.91	5.48
.442	6.19	6.10	5.75	5.50	4.87	5.88	5.43
.455	6.30	6.10	5.81	5.66	4.89	5.81	5.49
.464	6.40	6.20	5.80	5.65	5.09	6.01	5.52
.483	6.17	6.25	5.89	5.37	5.11	5.96	5.62
.494	5.57	6.09	5.81	5.29	5.33	5.96	5.61
.504	5.27	6.10	5.89	5.13	5.42	5.91	5.72
.514	4.93	6.30	5.97	5.10	5.47	5.85	5.73
.525	4.99	6.15	5.91	5.17	5.56	5.91	5.86
34 118.355	5.14	5.08	6.18	—	6.10	5.68	6.08
.372	6.14	5.15	6.00	—	6.28	5.81	5.79
.388	6.12	5.24	6.10	—	6.10	5.82	5.91
.428	6.22	5.38	6.05	4.86	6.31	5.92	5.65
.443	6.25	5.68	5.92	5.12	6.08	5.86	5.65
.470	5.94	5.94	5.90	5.24	—	5.84	5.39
.485	6.09	—	5.81	5.48	6.21	5.89	5.40
.499	6.24	5.85	5.73	5.23	5.99	5.82	5.42
.513	6.42	5.99	5.70	5.19	5.43	5.84	5.36
.526	6.46	6.02	5.60	—	5.07	5.57	5.60
.540	6.17	6.17	5.55	5.37	4.77	5.99	5.48
34 120.471	6.17	5.48	5.45	4.80	6.30	5.65	6.07
.484	6.24	5.57	5.57	4.79	—	5.57	6.00
.497	6.22	5.62	5.73	5.07	6.20	5.69	5.76
.510	6.19	5.76	5.70	5.06	—	5.66	5.80
.523	6.40	5.77	5.55	5.06	6.22	5.67	5.64
.536	6.09	5.72	5.70	4.90	6.20	5.72	5.54

Table 9 (continued)

J. D. 2 400 000 +	118	119	120	121	123	124	125
34 120.551	5.77	5.84	5.59	5.17	6.33	5.71	5.43
.564	5.15	5.95	5.78	5.03	6.18	5.78	5.55
.579	4.77	5.90	5.73	4.94	6.43	5.88	5.46
34 121.401	6.38	5.07	5.89	5.44	5.78	5.78	5.76
.412	6.17	5.03	6.17	5.50	5.91	5.74	5.86
.422	6.28	4.87	5.90	5.40	5.90	5.82	5.82
.431	6.12	4.85	5.86	5.54	5.99	5.90	5.88
.441	6.22	4.87	5.98	5.54	6.02	5.85	6.00
.484	6.17	5.30	6.06	5.15	6.06	5.86	6.06
.495	6.17	5.38	5.94	4.89	6.38	5.94	5.90
.505	6.33	5.56	6.00	4.98	6.04	5.83	5.88
.517	6.31	5.51	6.06	4.77	6.18	5.96	6.00
.528	6.18	5.57	5.89	4.86	6.28	5.87	5.94
.539	6.14	5.63	6.02	—	6.19	5.89	5.82
.552	5.63	5.61	6.03	—	6.25	5.84	5.78
.562	5.24	5.63	5.93	—	—	—	—
.594	4.80	5.92	6.10	—	6.14	5.74	5.49
.605	4.87	—	—	—	—	—	5.30
34 122.404	—	5.76	5.54	—	5.74	—	5.66
.416	6.32	5.54	5.58	—	5.58	5.74	5.65
.431	6.22	5.35	5.50	—	5.58	5.88	5.74
34 126.433	6.06	6.14	5.94	4.94	6.42	5.52	5.78
34 131.415	6.26	5.79	5.62	5.62	—	6.10	5.62
34 487.347	5.97	5.97	5.84	5.60	5.80	5.90	5.80
.367	6.38	6.12	5.62	5.84	5.94	5.92	6.07
.385	6.27	5.89	5.57	5.71	5.96	5.91	6.12
.397	*6.17*	*6.09*	*5.68*	*5.52*	*6.09*	*5.66*	*5.66*
.410	6.35	6.22	5.82	5.46	6.32	5.86	—
.428	6.15	5.72	5.78	5.76	5.95	5.63	5.83
.483	6.34	5.33	5.84	5.38	—	5.62	5.91
.449	6.36	5.11	5.93	5.70	—	5.65	5.93
.460	—	4.80	5.84	5.54	6.28	5.57	5.66
.474	5.93	4.84	6.01	5.44	—	5.48	5.62
.483	6.26	4.90	5.83	5.52	—	5.50	—
.494	—	4.95	5.83	—	—	5.50	5.48
.508	—	5.11	5.97	5.55	—	5.45	5.62
.518	6.10	5.17	—	5.50	—	5.59	5.60
34 488.530	6.29	5.05	5.59	5.54	5.97	5.81	5.77
.540	6.24	5.06	5.61	—	5.97	5.82	5.66
34 567.388	6.39	5.93	—	4.99	6.30	5.63	5.78
35 223.415	5.93	6.01	5.56	5.23	6.55	5.53	5.95
.428	6.28	6.20	5.58	5.32	6.13	5.54	6.02
.441	6.13	6.15	5.54	5.40	6.32	5.50	5.94
.467	6.37	6.12	5.57	5.19	6.19	5.60	5.88
.490	6.19	6.21	5.62	5.07	6.39	5.49	5.78
.503	6.31	6.20	5.54	4.83	6.27	5.65	5.65

Table 9 (continued)

J. D. 2 400 000 +	118	119	120	121	123	124	125
35 223.517	6.20	6.28	5.77	4.60	6.39	5.70	5.65
.530	6.39	6.28	5.65	4.58	—	5.65	5.58
.546	6.35	6.15	5.77	4.66	6.11	5.69	5.45
.573	6.14	6.05	6.03	4.82	5.95	5.60	5.45
35 224.454	6.21	6.15	6.08	5.29	6.21	5.74	5.86
.472	6.32	6.16	6.09	5.26	6.28	5.83	5.88
.485	6.18	6.12	6.04	5.41	6.32	5.85	5.90
.499	6.32	6.32	6.08	5.33	6.19	5.89	5.97
.512	6.38	6.26	6.28	5.42	—	5.79	5.86
.524	6.09	6.40	6.06	5.21	—	5.47	5.74
.542	6.42	6.26	6.04	5.20	—	5.77	5.65
.556	6.14	6.31	6.16	4.98	6.29	5.81	5.58
.569	6.35	6.22	6.01	4.86	—	5.80	5.65
.583	6.18	6.10	6.06	4.74	6.29	5.94	5.54
35 227.534	6.60	6.49	6.02	5.75	5.62	5.91	5.62
.547	6.32	6.30	5.88	5.67	5.70	6.12	5.85
.560	6.42	6.42	5.72	5.70	5.70	6.11	5.97
.573	6.23	6.19	5.82	5.56	6.04	—	5.82
.586	5.96	6.19	5.81	6.00	5.81	5.71	5.88
35 598.507	6.42	5.28	5.74	5.62	5.84	5.92	5.82
.524	6.44	4.84	5.54	5.52	5.81	6.14	5.57
.537	6.36	4.81	5.54	5.54	—	5.94	5.58
35 600.363	5.88	6.12	6.13	4.83	—	5.66	5.79
.378	5.70	6.03	5.90	4.91	—	5.40	5.53
.391	6.07	6.16	6.03	5.02	6.42	5.48	5.58
.405	6.03	6.48	5.80	5.05	—	5.44	5.90
.421	5.90	6.29	5.80	5.14	—	5.41	5.68
.434	5.83	6.10	5.84	5.23	6.19	5.64	5.69
.446	5.98	6.13	5.66	5.22	6.43	5.64	5.75
.501	6.39	6.29	5.64	5.39	5.92	5.61	6.09
.525	6.58	6.28	5.52	5.36	5.02	5.92	6.16
35 603.369	5.78	5.80	6.10	—	5.68	5.53	5.97
.381	5.86	5.88	6.06	—	5.84	5.57	5.78
.397	5.89	5.86	6.14	5.47	5.99	5.61	5.59
.408	5.90	6.02	6.08	5.06	5.78	5.50	5.54
.419	6.14	6.04	5.94	5.45	5.98	5.50	5.74
.431	5.90	6.28	6.04	5.25	5.91	5.65	5.70
.446	6.02	6.14	6.02	5.35	6.17	5.66	5.53
.457	6.25	6.17	6.16	4.97	6.16	5.66	5.54
.468	6.14	6.25	6.16	4.87	6.35	5.57	5.46
.491	6.23	6.10	6.10	4.68	6.10	5.60	5.52
.507	6.20	6.12	6.02	4.72	6.12	5.72	5.51
35 920.444	5.41	5.95	6.11	5.01	6.59	5.51	5.25
.467	5.64	6.05	5.80	5.15	6.38	5.56	5.53
.487	5.67	5.67	5.49	5.07	—	5.58	5.76
.504	5.91	5.62	5.66	—	6.18	5.73	5.76

Table 9 (continued)

J. D. 2 400 000 +	118	119	120	121	123	124	125
35 920.547	6.10	4.92	5.52	5.15	6.50	5.56	5.97
.562	6.12	4.82	5.50	4.90	6.56	5.77	5.92
.585	6.14	4.84	5.63	5.00	6.22	5.66	5.89
35 933.415	5.52	6.04	5.60	—	6.04	5.69	5.38
.443	5.89	5.86	5.52	5.43	6.21	5.86	5.78
.479	5.80	5.43	5.72	5.08	6.10	5.84	5.74
.503	5.72	4.81	5.69	—	6.03	5.72	5.72
.515	6.09	4.55	5.75	—	6.35	5.99	6.13
.530	6.08	4.87	5.98	5.10	6.08	5.74	5.92
.543	6.08	4.94	6.18	—	—	5.71	5.81
.573	6.18	5.27	6.04	5.15	6.02	5.62	5.95
.588	—	5.68	6.09	—	—	5.56	5.58
.602	—	5.39	6.06	—	—	—	5.87
36 991.457	5.98	6.00	5.56	5.79	—	5.71	5.92
.470	—	6.27	5.69	5.72	5.06	—	5.96
.485	6.04	6.27	5.71	5.74	5.35	5.69	5.83
37 018.470	5.51	6.15	5.73	4.96	—	6.10	5.46
.483	5.16	6.22	5.66	4.70	—	6.05	5.44
.496	4.91	6.39	5.74	4.63	—	5.69	5.55
.510	4.96	6.16	5.71	4.88	—	5.78	5.65
.523	5.14	6.23	6.00	4.88	—	5.82	5.59
.537	5.24	5.87	5.58	4.92	—	5.64	5.80
.550	5.30	—	5.82	5.05	—	5.80	5.54
.563	5.34	6.26	5.68	5.00	6.48	5.62	5.70
.577	5.50	6.16	5.82	5.12	—	5.72	5.68
.609	5.84	6.12	5.94	5.38	—	5.54	5.86
.623	5.89	5.99	5.82	4.92	—	5.70	5.84
.637	6.00	5.30	6.11	5.49	—	5.77	5.92
37 057.539	5.57	4.96	5.81	5.47	5.69	5.95	6.15
.552	5.79	5.14	5.75	—	5.75	6.01	6.01
.578	5.89	5.28	6.04	4.96	5.94	5.84	5.94
37 058.529	5.50	5.45	6.05	5.50	4.89	5.50	6.01
.580	5.97	5.08	5.93	5.59	5.36	5.53	6.11
37 757.598	4.90	—	—	—	6.17	5.44	5.81
37 791.365	6.21	5.85	6.03	4.75	6.11	5.60	5.60
.380	6.23	5.98	5.93	4.74	6.33	—	5.89
.394	6.29	5.94	5.97	5.05	6.42	5.56	5.83
.424	6.27	6.17	6.02	5.11	6.31	5.51	5.95
.439	6.20	6.06	6.02	5.06	6.25	5.50	5.96
.454	6.36	5.99	5.97	5.53	6.39	5.47	5.81
.469	6.35	6.09	5.97	5.11	6.10	5.51	5.96
.483	6.22	6.13	6.09	5.28	6.30	5.34	5.74
.479	6.27	6.13	5.96	5.22	6.42	5.34	5.96
.519	5.70	6.19	6.09	5.36	6.37	5.53	5.85
.533	5.07	6.07	6.15	5.03	6.32	5.50	5.68
.549	4.99	6.04	5.98	5.25	6.12	5.57	5.66
.563	5.02	6.30	6.00	—	5.98	5.63	5.60

Table 9 (continued)

J. D. 2 400 000 +	126	131	140	142	202	203
28 963.487	5.84	5.15	5.00	5.46	5.67	—
28 991.403	5.72	5.21	4.88	5.35	5.78	—
.416	5.72	4.93	5.00	5.11	5.72	—
.430	5.78	4.80	4.87	5.03	5.81	—
.522	5.27	4.70	—	—	5.64	—
.542	5.12	5.17	4.98	4.90	5.92	—
29 346.376	5.72	5.27	5.30	5.14	5.81	—
.392	5.87	5.41	5.54	—	5.61	—
29 719.549	5.80	5.21	5.38	5.53	5.70	—
.560	5.79	4.98	5.41	5.46	5.87	—
29 720.546	5.67	5.30	5.42	5.45	5.78	—
.558	5.62	5.34	5.32	5.39	5.80	—
29 774.405	5.39	5.13	5.33	5.49	5.80	—
.417	5.45	5.39	5.42	5.54	5.80	—
29 775.403	5.48	5.46	5.48	5.08	5.79	—
.415	5.59	5.44	5.53	5.10	5.89	—
.426	5.53	5.62	5.48	5.25	5.83	—
.437	5.44	5.54	5.54	5.54	5.90	—
.447	5.24	5.47	5.47	5.51	5.80	—
30 052.462	5.55	5.41	5.01	—	5.83	5.60
.474	5.57	5.54	5.09	5.92	6.02	5.66
.489	5.45	5.25	5.29	5.66	5.80	5.59
.501	5.51	5.89	5.35	5.80	5.94	5.66
30 078.418	5.92	5.64	5.02	5.11	5.72	5.58
.434	5.84	5.39	4.91	4.76	5.71	5.61
.470	5.83	5.40	5.08	4.96	5.75	—
.483	5.76	5.60	5.08	4.85	5.76	—
.498	5.58	5.49	5.10	5.03	5.74	5.56
.509	5.60	5.38	5.08	5.11	5.83	5.56
.521	5.62	5.32	5.23	5.09	5.83	5.52
.536	5.53	5.17	5.25	5.28	5.79	5.60
.548	5.43	5.13	5.31	5.13	5.75	5.56
33 390.497	5.57	5.13	5.24	5.53	5.72	5.67
.534	5.47	5.37	5.40	5.62	5.65	—
.545	5.48	5.67	5.51	5.51	5.80	5.56
.558	5.43	5.50	5.48	5.59	5.87	5.51
.570	5.52	5.57	5.50	5.38	5.76	5.45
.586	5.63	5.72	5.53	5.55	5.63	5.64
33 420.424	5.46	5.37	5.09	5.40	5.98	5.45
.438	5.73	5.37	5.19	5.59	5.90	5.61
.450	5.58	5.06	5.23	5.46	5.83	5.68
.476	5.45	5.24	5.32	5.45	5.93	5.64
.487	5.48	5.13	5.33	5.45	5.76	5.69
.498	5.35	5.02	5.35	5.56	6.16	5.70
.510	5.55	5.23	5.32	5.48	5.90	5.58
.523	5.42	4.98	5.31	5.68	5.90	5.69

Table 9 (continued)

J. D. 2 400 000 +	126	131	140	142	202	203
33 421.385	5.76	5.14	5.01	4.82	5.76	—
.442	5.81	5.40	5.03	4.94	5.73	5.78
.454	5.51	5.30	5.24	5.05	5.75	5.75
.465	5.54	5.27	5.17	4.88	5.82	5.66
.475	5.39	5.25	5.18	5.02	5.87	5.68
.486	5.41	5.29	5.27	5.14	5.80	5.59
.497	5.47	5.37	5.32	5.26	5.77	5.64
.535	5.47	5.63	5.54	5.44	5.70	5.57
.548	5.44	5.44	5.58	—	5.66	5.51
33 422.398	6.24	5.51	5.18	5.62	5.54	5.52
.431	6.05	5.95	5.25	5.50	5.65	5.58
.442	5.86	5.73	5.32	5.65	5.73	5.40
.452	5.92	—	5.33	5.50	5.76	5.49
.462	5.89	5.57	5.37	—	5.74	—
.472	5.96	5.60	5.36	5.27	5.83	5.71
.483	5.95	5.64	5.40	4.91	5.78	5.66
.493	5.88	5.44	5.42	4.99	5.76	5.67
.508	5.46	5.33	5.51	4.92	5.94	5.61
.520	5.64	5.33	5.36	4.70	5.69	5.68
33 763.406	5.70	5.12	5.56	5.51	5.78	—
.420	5.63	5.23	5.57	5.63	5.71	5.67
.442	5.75	5.12	5.45	5.79	5.75	5.72
.455	5.85	5.20	5.37	5.92	—	—
.464	5.99	5.21	5.41	5.89	5.65	5.66
.483	5.98	5.25	5.23	—	5.73	5.60
.494	5.83	5.24	5.19	5.72	5.64	5.63
.504	5.93	5.23	5.18	5.74	5.64	5.53
.514	5.88	5.47	5.20	5.76	5.65	5.48
.525	5.86	5.58	5.13	6.09	5.65	5.53
34 118.355	5.44	—	5.29	—	5.88	5.67
.372	5.30	—	5.20	—	5.84	5.56
.388	5.36	—	5.31	—	5.94	5.60
.428	5.72	5.30	5.44	5.99	5.82	5.62
.443	5.74	5.30	5.53	5.98	5.76	5.71
.470	5.69	5.50	5.60	—	5.89	5.63
.485	5.86	5.66	5.52	5.24	5.71	5.66
.499	5.90	5.45	5.45	5.06	5.73	5.48
.513	5.82	5.33	5.60	4.68	5.60	5.60
.526	5.62	5.15	5.45	4.73	5.91	—
.540	6.03	5.11	5.19	5.11	5.55	5.44
34 120.471	5.48	—	5.48	—	5.76	5.55
.484	5.42	—	5.49	—	5.81	5.60
.497	5.60	—	—	5.57	5.87	5.52
.510	5.59	5.47	5.48	5.58	5.89	5.45
.523	5.59	5.52	5.41	5.71	5.84	5.42
.536	5.82	5.45	5.41	—	5.84	5.35

Table 9 (continued)

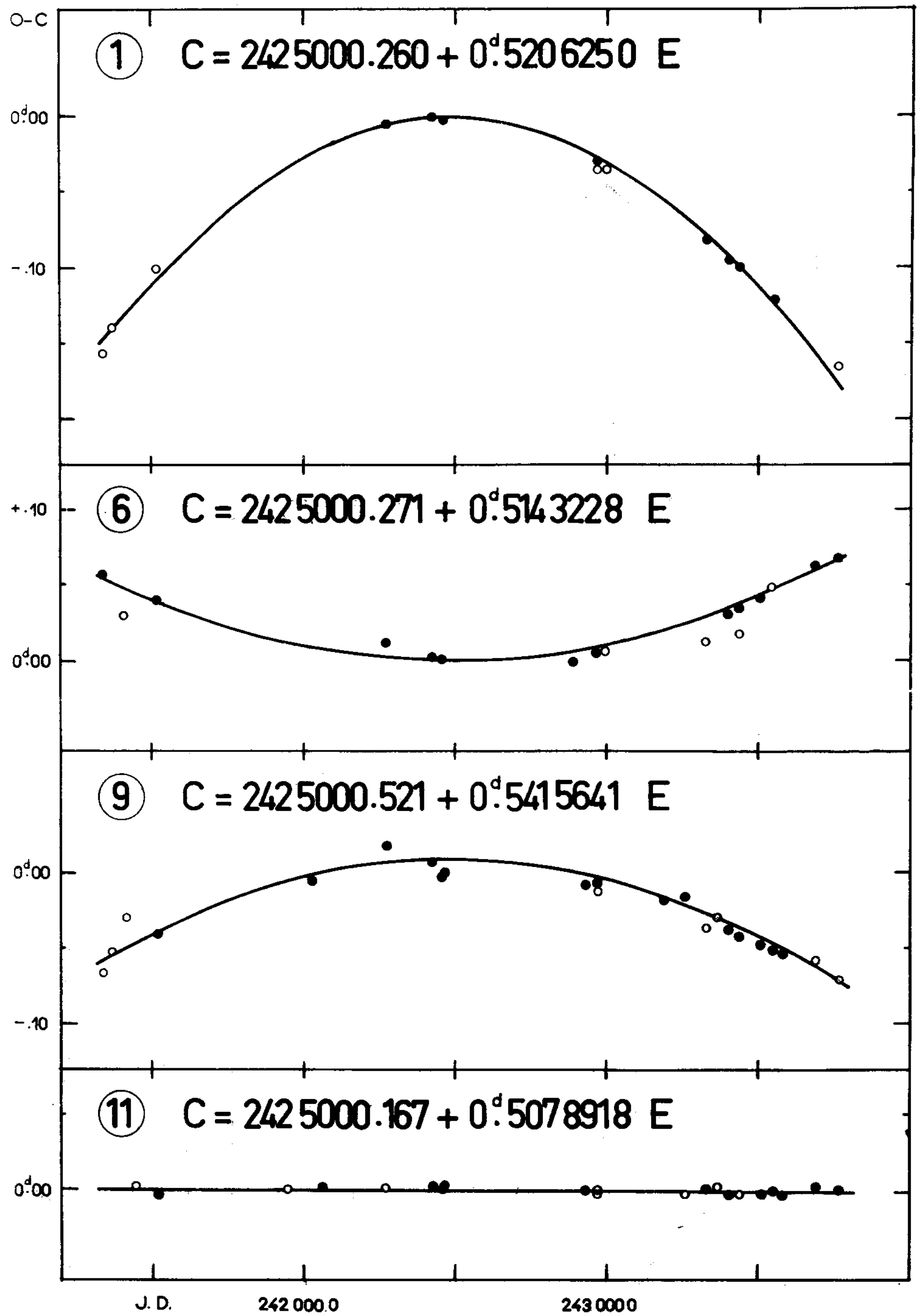
J. D. 2 400 000 +	126	131	140	142	202	203
34 120.551	5.80	5.65	5.13	5.71	5.91	5.51
.564	5.78	5.34	5.21	5.50	5.84	5.64
.579	5.88	5.43	5.10	5.40	6.00	5.57
34 121.401	5.48	5.48	5.35	5.07	5.89	5.48
.412	5.64	5.53	5.42	5.09	6.10	5.49
.442	5.50	5.56	5.53	5.14	5.82	5.60
.431	5.51	5.56	5.49	5.12	5.83	5.48
.441	5.50	5.60	5.62	5.14	5.88	5.60
.484	5.43	5.46	5.56	5.34	5.84	5.57
.495	5.51	5.38	5.58	5.15	5.81	5.60
.505	5.51	5.35	5.54	5.35	5.76	5.63
.517	5.54	5.18	5.44	5.51	5.94	5.72
.528	5.49	5.10	5.33	5.40	5.81	5.76
.539	5.51	—	5.32	—	5.84	5.66
.552	5.59	—	5.08	—	5.78	5.69
.562	5.56	5.00	5.12	—	5.73	5.62
.594	5.68	5.03	5.00	5.66	5.66	5.66
.605	—	—	5.11	—	5.83	5.67
34 122.404	5.85	—	5.46	—	5.66	—
.416	—	4.97	5.47	—	5.65	5.72
.431	5.82	5.01	5.50	—	5.74	5.67
34 126.433	5.58	5.38	5.50	5.50	5.63	5.69
34 131.415	5.78	5.11	5.54	5.68	5.88	—
34 487.347	5.62	5.36	5.38	5.38	5.80	—
.367	5.69	5.45	5.36	—	5.91	—
.385	5.89	5.33	5.22	5.91	5.86	—
.397	5.66	5.10	5.04	5.56	5.82	—
.410	5.90	5.24	—	5.49	5.84	—
.428	—	4.95	5.01	—	5.72	—
.438	5.81	5.04	5.06	5.60	5.84	—
.449	6.03	5.19	5.04	5.90	5.87	—
.460	5.91	5.18	5.18	5.87	5.66	—
.474	5.82	5.27	5.14	5.74	5.68	—
.483	5.83	5.18	5.23	5.59	5.72	—
.494	5.90	5.19	5.26	—	5.73	—
.508	6.00	5.09	5.27	5.39	5.62	—
.518	5.95	5.37	5.43	5.50	5.73	—
34 488.530	5.91	5.37	5.44	5.66	5.79	—
.540	5.82	5.42	5.46	5.63	5.74	—
34 567.388	5.56	5.76	5.16	5.52	5.76	—
35 223.415	5.53	5.13	5.33	4.90	5.72	—
.428	5.54	5.34	5.40	4.93	5.79	—
.441	5.50	5.37	5.43	5.04	5.79	—
.467	5.32	5.44	5.46	5.09	5.71	—
.490	5.49	5.68	5.49	5.24	5.76	—
.503	5.44	5.45	5.40	5.28	5.81	—

Table 9 (continued)

J. D. 2 400 000 +	126	131	140	142	202	203
35 223.517	5.51	5.31	5.24	5.29	5.85	—
.530	5.47	5.40	5.24	5.14	5.81	—
.546	5.51	5.20	5.08	5.36	5.71	—
.573	5.69	5.10	5.10	—	5.71	—
35 224.454	5.60	5.14	5.54	5.21	5.76	—
.472	5.42	4.92	5.62	5.08	5.96	—
.485	5.41	5.08	5.47	4.90	5.85	—
.499	5.38	5.08	5.50	4.96	5.94	—
.512	5.40	4.90	5.40	4.71	5.86	—
.524	5.26	4.98	5.23	4.81	5.82	—
.542	5.30	5.04	5.24	4.90	5.74	—
.556	5.46	5.09	5.06	—	5.81	—
.569	5.54	5.29	5.10	5.07	5.79	—
.583	5.49	5.25	5.06	5.15	5.85	—
35 227.534	6.15	5.33	5.35	5.49	5.75	—
.547	5.98	5.35	—	5.70	5.83	—
.560	6.17	5.54	5.24	5.75	5.63	—
.573	5.82	5.40	5.23	—	5.56	—
.586	5.86	5.24	5.10	5.60	6.00	—
35 598.507	5.88	5.35	5.30	5.60	5.64	5.73
.524	5.98	5.48	5.42	5.61	5.67	5.58
.537	5.94	5.43	5.73	5.94	5.75	5.60
35 600.363	5.99	5.50	5.00	4.70	5.88	5.74
.378	5.48	5.40	5.04	4.85	5.94	5.56
.391	5.67	5.46	5.12	5.02	5.71	5.67
.405	5.55	5.66	5.27	4.94	5.77	5.80
.421	5.60	5.38	5.11	4.93	5.88	5.65
.434	5.49	5.32	5.16	4.95	5.77	5.65
.446	5.53	5.29	5.08	5.24	5.80	5.66
.501	5.54	5.07	5.39	5.26	5.90	—
.525	5.58	5.10	5.56	5.50	6.01	5.67
35 603.369	5.70	—	5.03	—	6.00	5.70
.381	5.80	—	5.14	5.60	5.80	5.75
.397	5.61	5.37	5.10	5.32	5.92	5.48
.408	5.80	5.19	4.98	5.27	6.21	5.58
.419	5.94	5.28	5.15	5.56	5.92	5.57
.431	5.96	5.14	5.22	5.54	5.85	5.62
.446	6.00	5.11	5.24	5.60	5.84	5.47
.457	5.91	4.97	5.29	5.57	5.82	5.56
.468	5.98	4.90	5.12	5.40	5.90	5.47
.491	5.68	4.96	5.45	5.58	5.87	5.58
.507	5.64	5.14	5.38	5.56	5.86	5.45
35 920.444	5.28	5.35	5.02	5.99	5.89	—
.467	5.80	5.50	5.07	—	5.80	—
.487	5.99	5.79	.488	4.70	5.67	—
.504	5.66	5.30	4.64	—	5.80	—

Table 9 (continued)

J. D. 2 400 000 +	126	131	140	142	202	203
35 920.547	5.65	4.96	4.66	5.10	5.80	—
.562	5.20	4.73	4.64	—	5.80	—
.585	5.17	4.84	4.68	—	5.87	—
35 933.415	5.58	5.30	5.30	5.43	5.64	—
.443	5.67	5.45	5.33	5.86	5.68	—
.479	5.39	5.26	5.11	5.39	5.80	—
.503	5.27	5.19	4.89	—	5.86	—
.515	5.33	5.21	4.97	—	5.91	—
.530	5.49	5.21	4.84	5.49	5.74	—
.543	4.94	—	4.62	—	5.76	—
.573	—	4.90	4.78	—	5.79	—
.588	5.28	—	4.88	—	5.58	—
.602	5.26	—	4.78	—	5.66	—
36 991.457	5.71	—	5.60	—	5.70	—
.470	6.11	—	5.69	5.61	5.75	—
.485	6.15	—	5.43	—	5.74	—
37 018.470	5.44	—	5.52	5.49	5.84	—
.483	—	—	5.37	5.43	5.92	—
.496	5.62	—	5.04	4.48	5.96	—
.510	5.71	—	5.15	4.85	5.84	—
.523	5.55	—	5.07	4.35	5.96	—
.537	5.69	—	4.93	—	—	—
.550	5.54	—	5.23	4.90	5.90	—
.563	5.60	—	5.11	5.20	5.81	—
.577	5.72	—	5.18	5.03	5.70	—
.609	5.78	—	5.16	5.12	5.74	—
.623	6.14	—	5.49	5.35	5.72	—
.637	—	—	5.62	5.40	5.87	—
37 057.539	5.57	—	4.95	—	5.69	—
.552	5.65	—	5.31	—	5.79	—
.578	5.89	—	5.34	—	5.89	—
37 058.529	5.45	—	5.18	—	5.81	—
.580	—	—	—	—	5.83	—
37 757.598	5.72	—	5.15	—	5.94	5.74
37 791.365	5.54	5.54	4.80	5.31	5.81	5.64
.380	5.83	5.34	5.02	5.22	5.79	5.56
.394	5.71	5.56	5.16	5.54	5.72	5.56
.424	5.67	5.49	5.04	5.53	5.78	5.51
.439	5.90	5.31	5.03	5.43	5.77	5.67
.454	5.60	5.60	—	—	5.64	5.64
.469	5.72	5.14	4.82	5.53	5.66	5.67
.483	5.56	4.92	4.88	5.31	5.65	5.65
.497	5.50	4.88	4.85	5.37	5.60	5.66
.519	—	4.96	5.10	—	5.67	5.70
.533	5.40	4.82	5.07	5.37	5.71	5.74
.549	5.46	4.89	5.30	5.40	5.66	5.62
.563	5.46	4.98	5.19	5.54	5.70	5.70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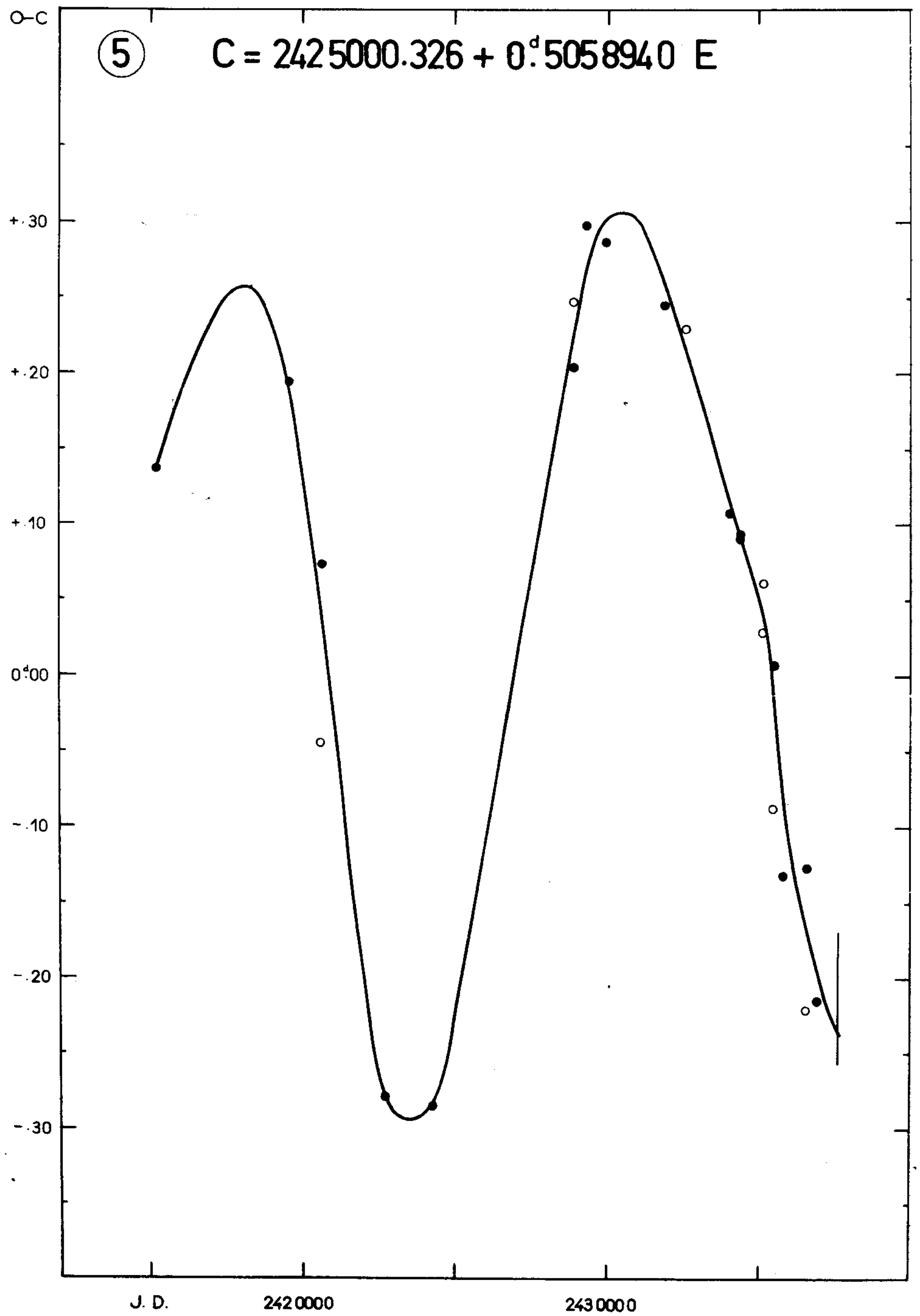
J. D.
242 000.0
243 000.0

Fig. 28.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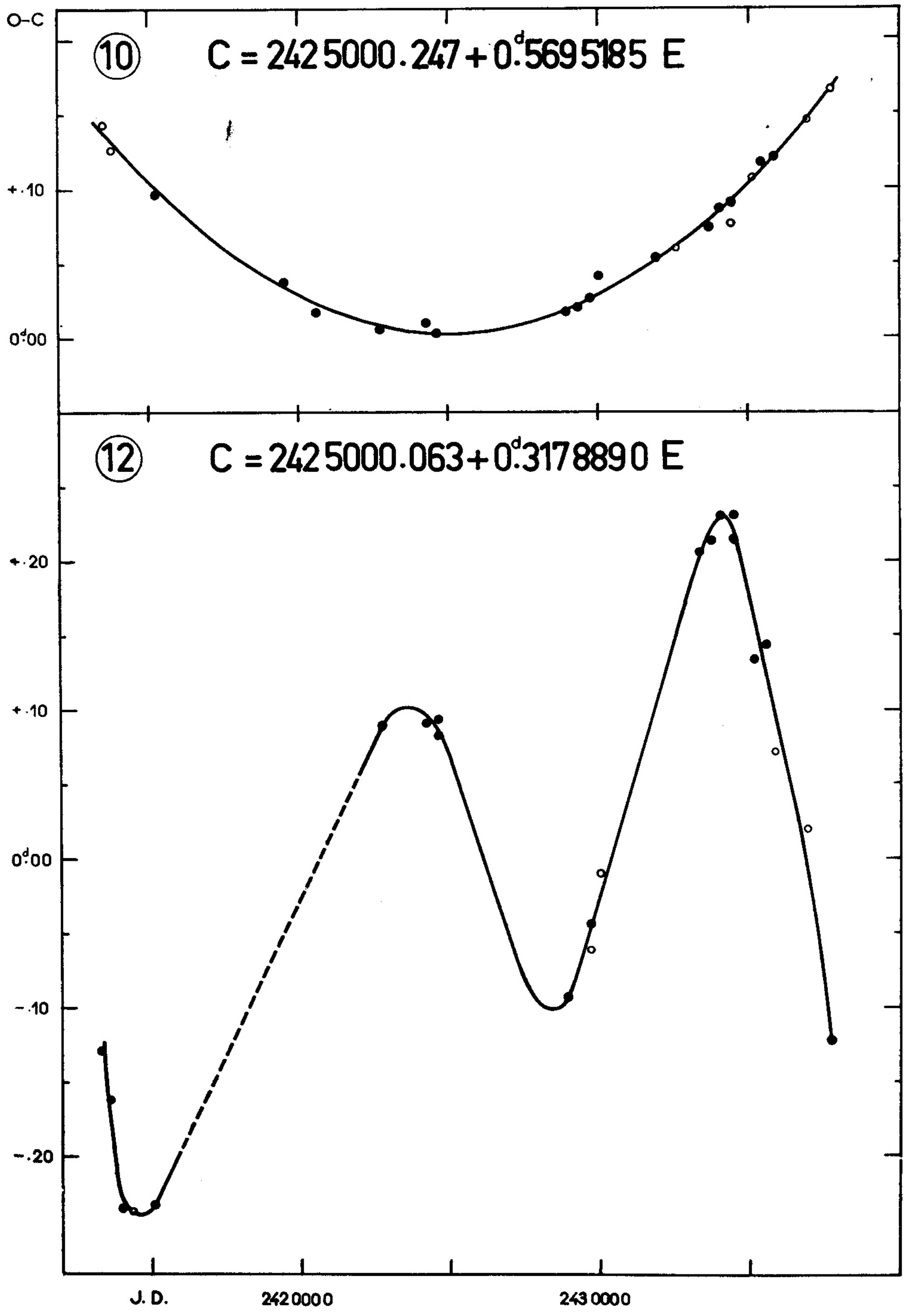
J. D.
2420000
2430000

Fig. 29.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–.10
–.20
J. D.
2420000
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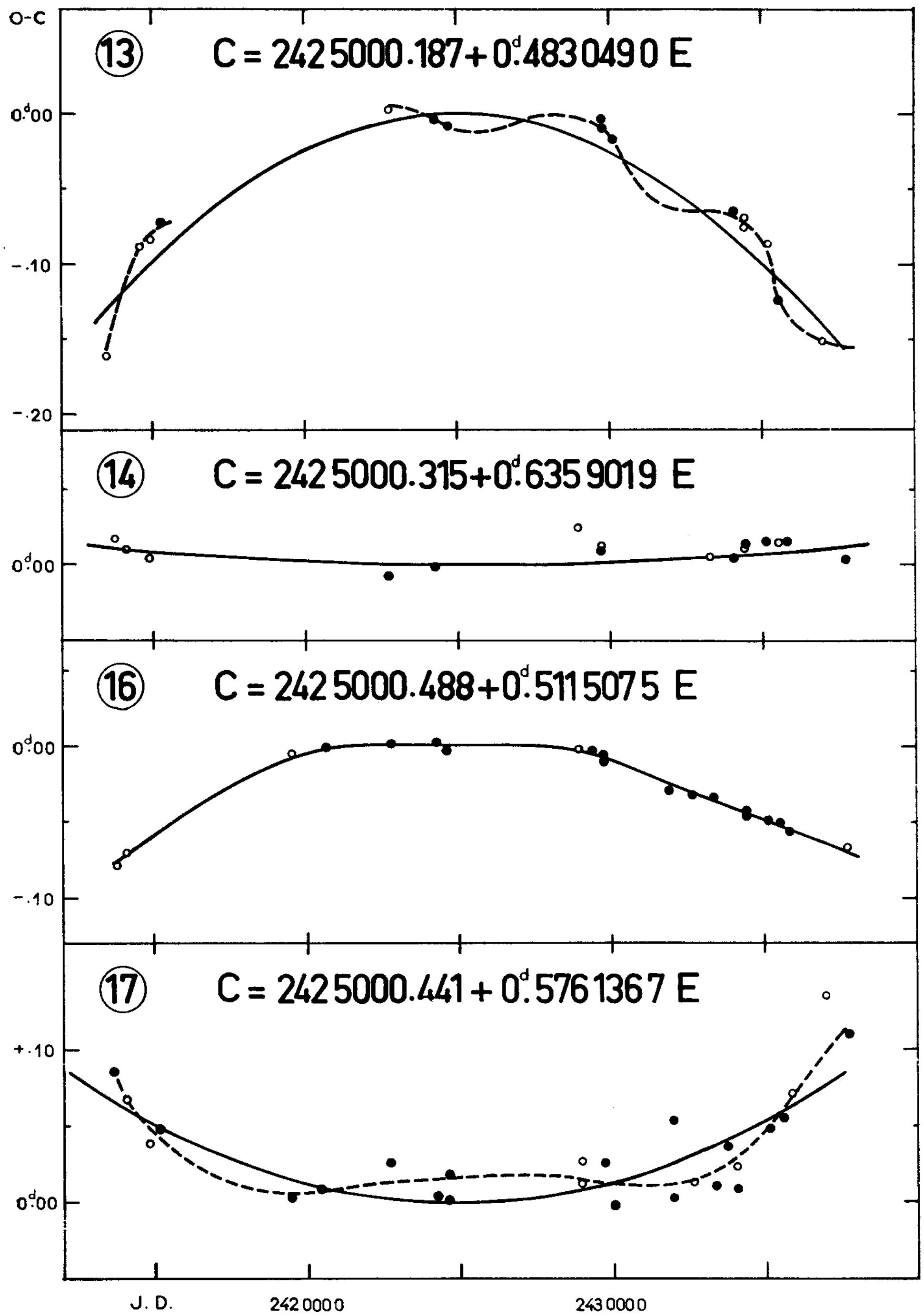
Fig. 30.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(16) C = 2425000.488+0.d5115075 E
0.d00
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(17) C = 2425000.441 + 0.d5761367 E
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J. D.
2420000
2430000

Fig. 31.

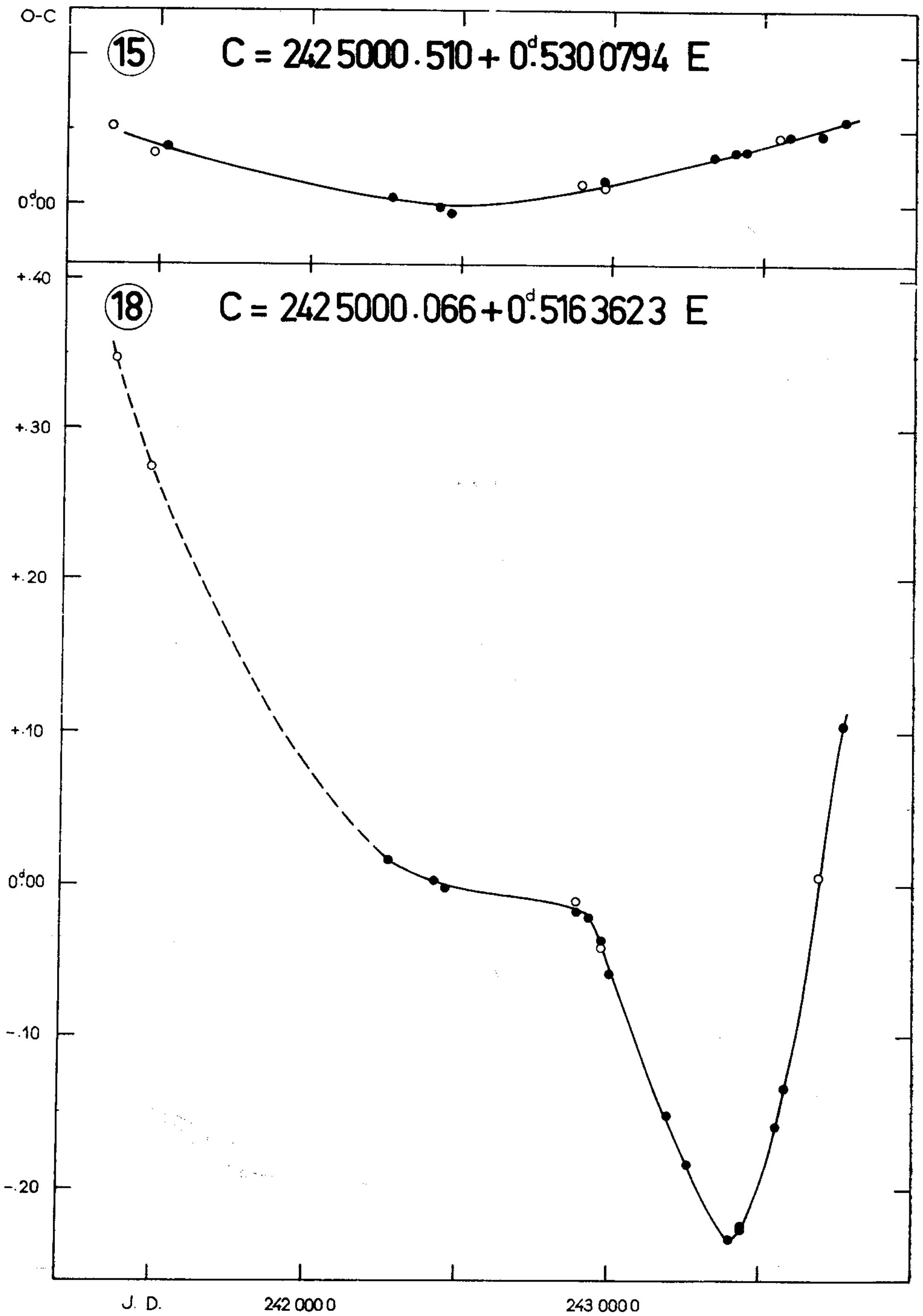

O-C
15
C = 242 5000.510 + 0.ᵈ530 0794 E
0.ᵈ00
+.40
18
C = 242 5000.066 + 0.ᵈ516 3623 E
+.30
+.20
+.10
0.ᵈ00
-.10
-.20
J. D.
242 000 0
243 000 0

Fig. 32.

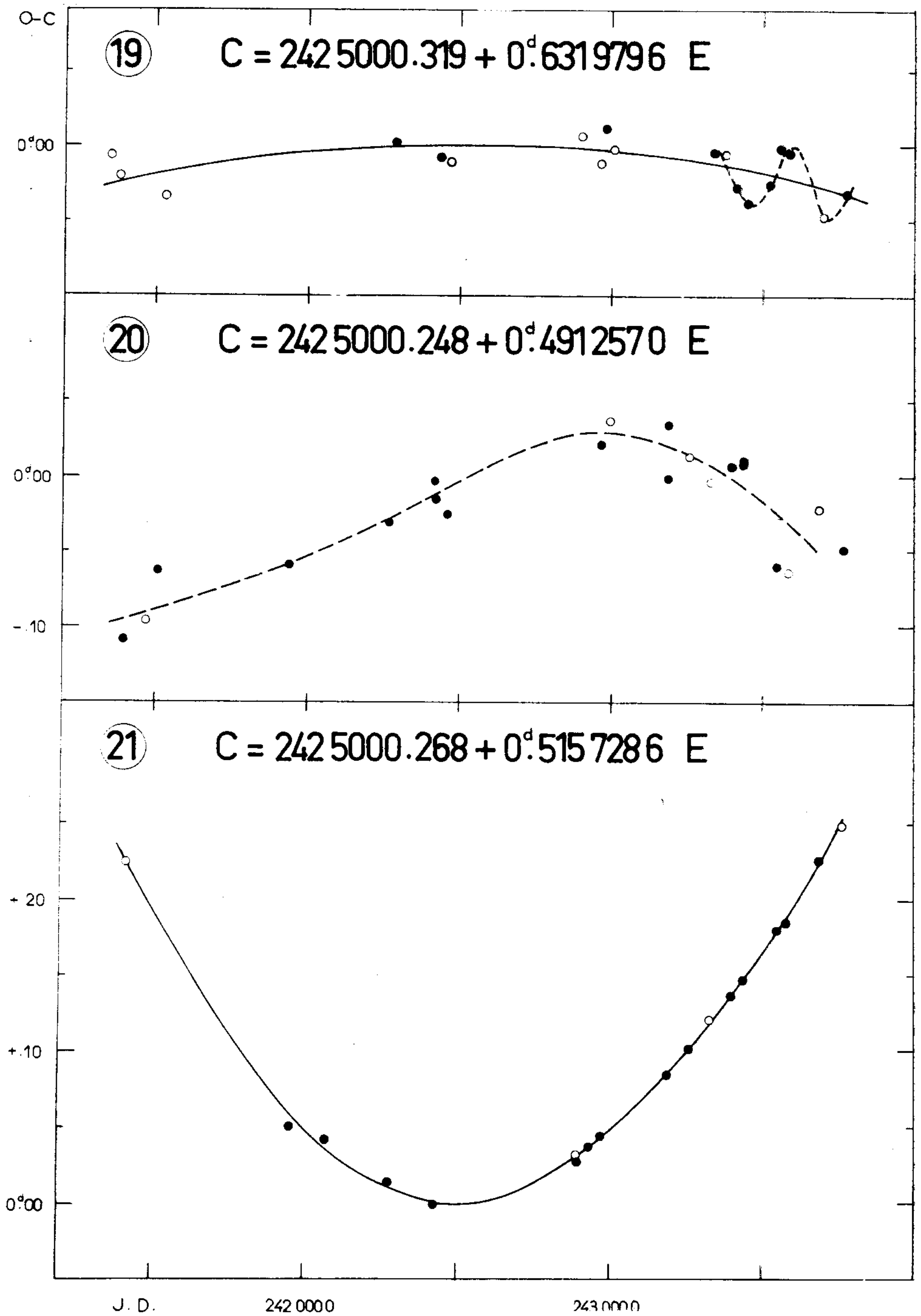

O–C
19
C = 2425000.319 + 0ᵈ.6319796 E
0ᵈ00
20
C = 2425000.248 + 0ᵈ.4912570 E
0ᵈ00
–.10
21
C = 2425000.268 + 0ᵈ.5157286 E
+.20
+.10
0ᵈ00
J.D.
2420000
2430000

Fig. 33.

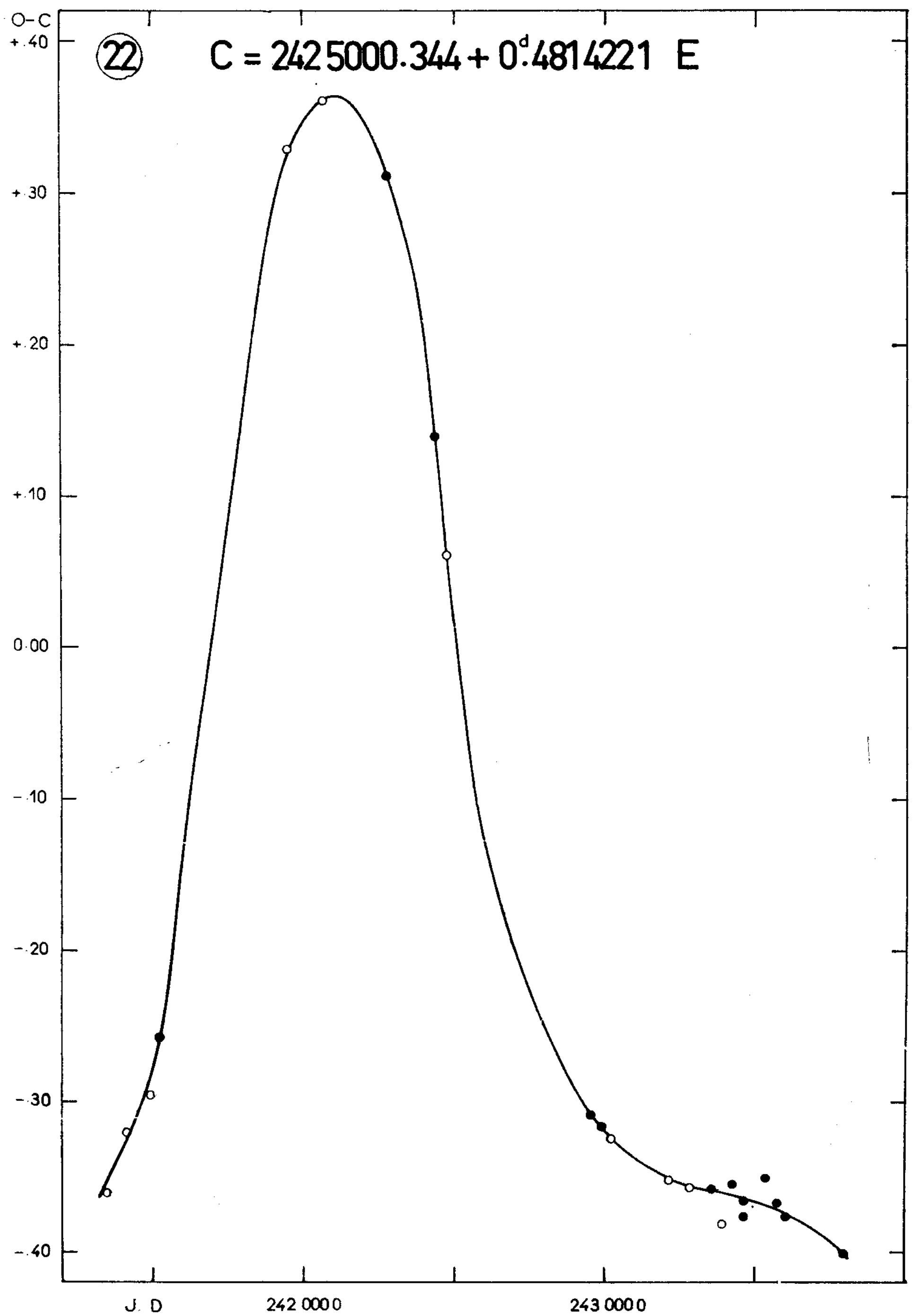

O–C
+.40
+.30
+.20
+.10
0.00
–.10
–.20
–.30
–.40
22
C = 2425000.344 + 0d.4814221 E
J. D
242 0000
243 0000

Fig. 34.

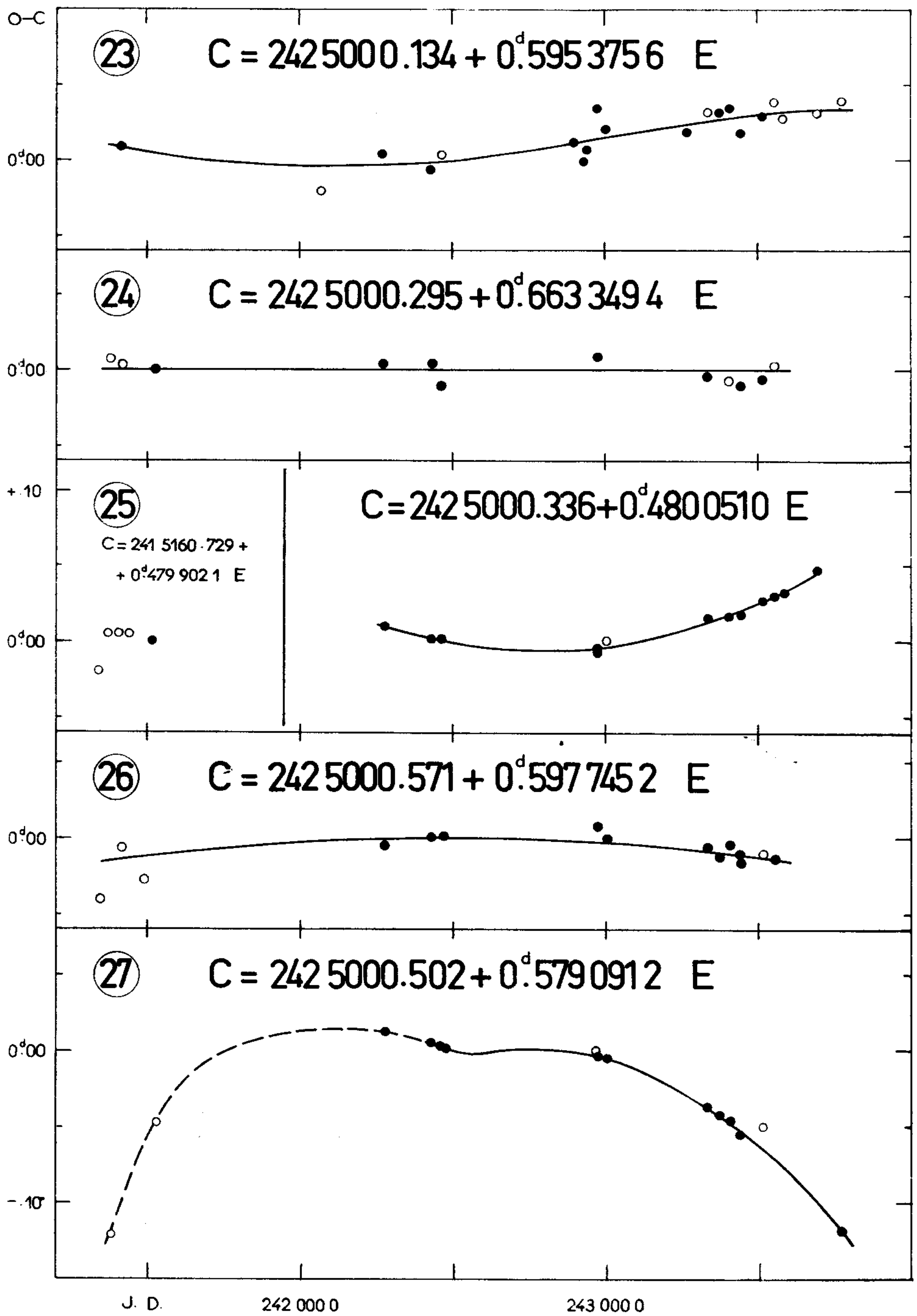

O–C
23
C = 242 5000.134 + 0.d595 375 6 E
0.d00
24
C = 242 5000.295 + 0.d663 349 4 E
0.d00
+.10
25
C = 241 5160.729 +
+ 0.d479 902 1 E
C = 242 5000.336 + 0.d480 0510 E
0.d00
26
C = 242 5000.571 + 0.d597 745 2 E
0.d00
27
C = 242 5000.502 + 0.d579 091 2 E
0.d00
–.10
J. D.
242 000 0
243 000 0

Fig. 35.

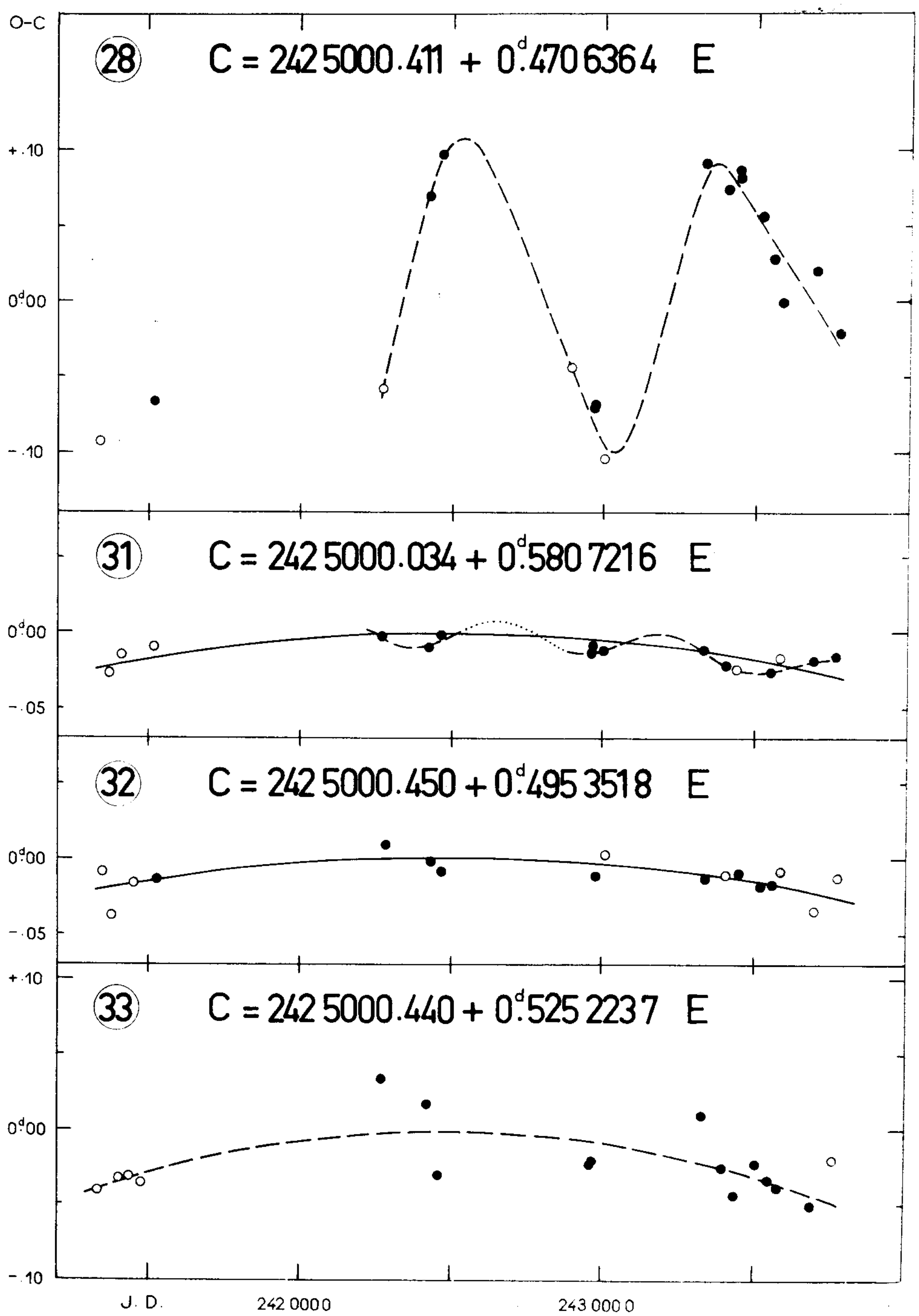
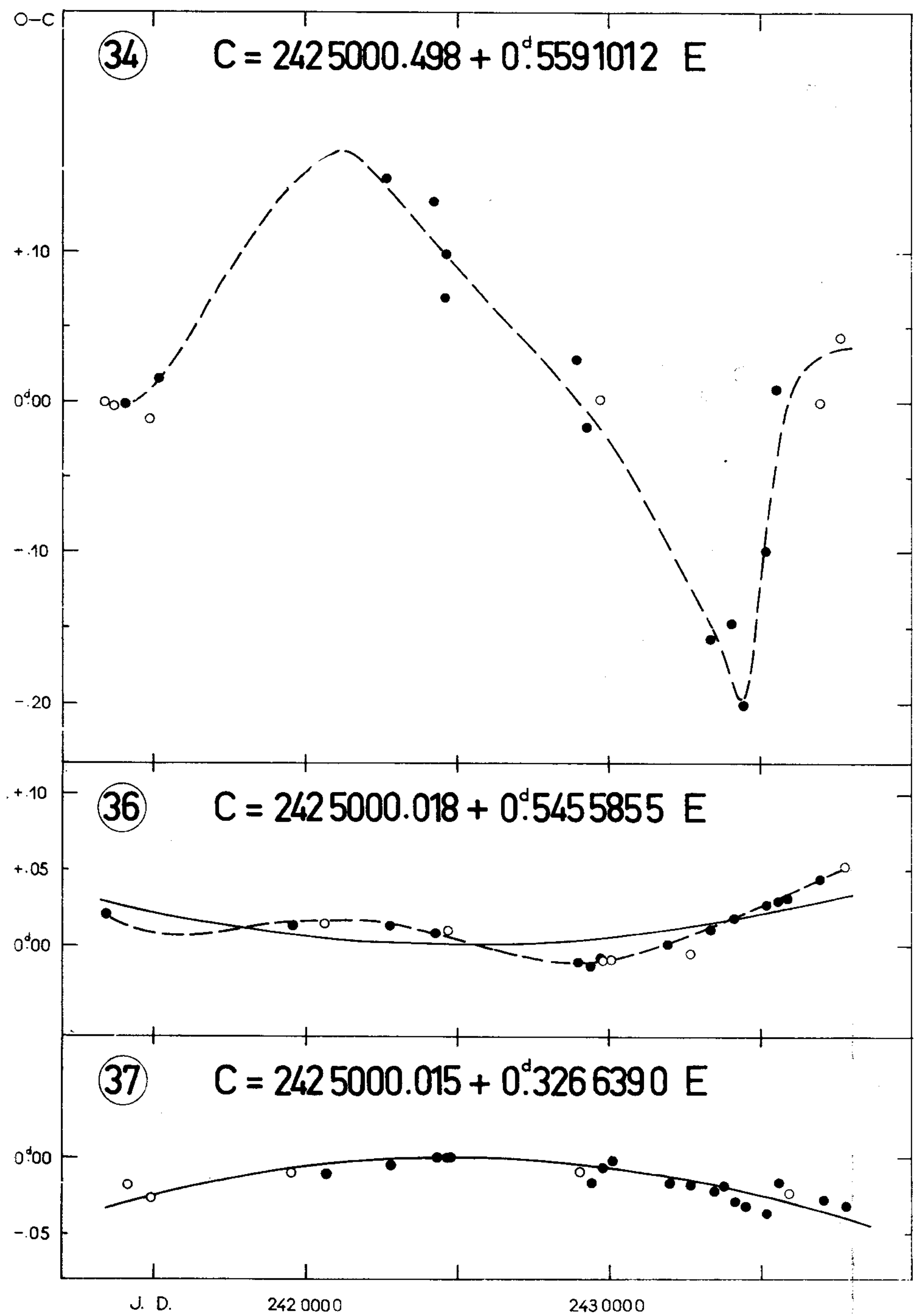

O–C
28
C = 242 5000.411 + 0ᵈ.470 6364 E
+ .10
0ᵈ00
– .10
31
C = 242 5000.034 + 0ᵈ.580 7216 E
0ᵈ00
– .05
32
C = 242 5000.450 + 0ᵈ.495 3518 E
0ᵈ00
– .05
+ .10
33
C = 242 5000.440 + 0ᵈ.525 2237 E
0ᵈ00
– .10
J. D.
242 0000
243 0000

Fig. 36.



O–C
34
C = 242 5000.498 + 0ᵈ.5591012 E
+.10
0ᵈ.00
–.10
–.20
36
C = 242 5000.018 + 0ᵈ.545 5855 E
+.10
+.05
0ᵈ.00
37
C = 242 5000.015 + 0ᵈ.326 6390 E
0ᵈ.00
–.05
J. D.
242 0000
243 0000

Fig. 37.

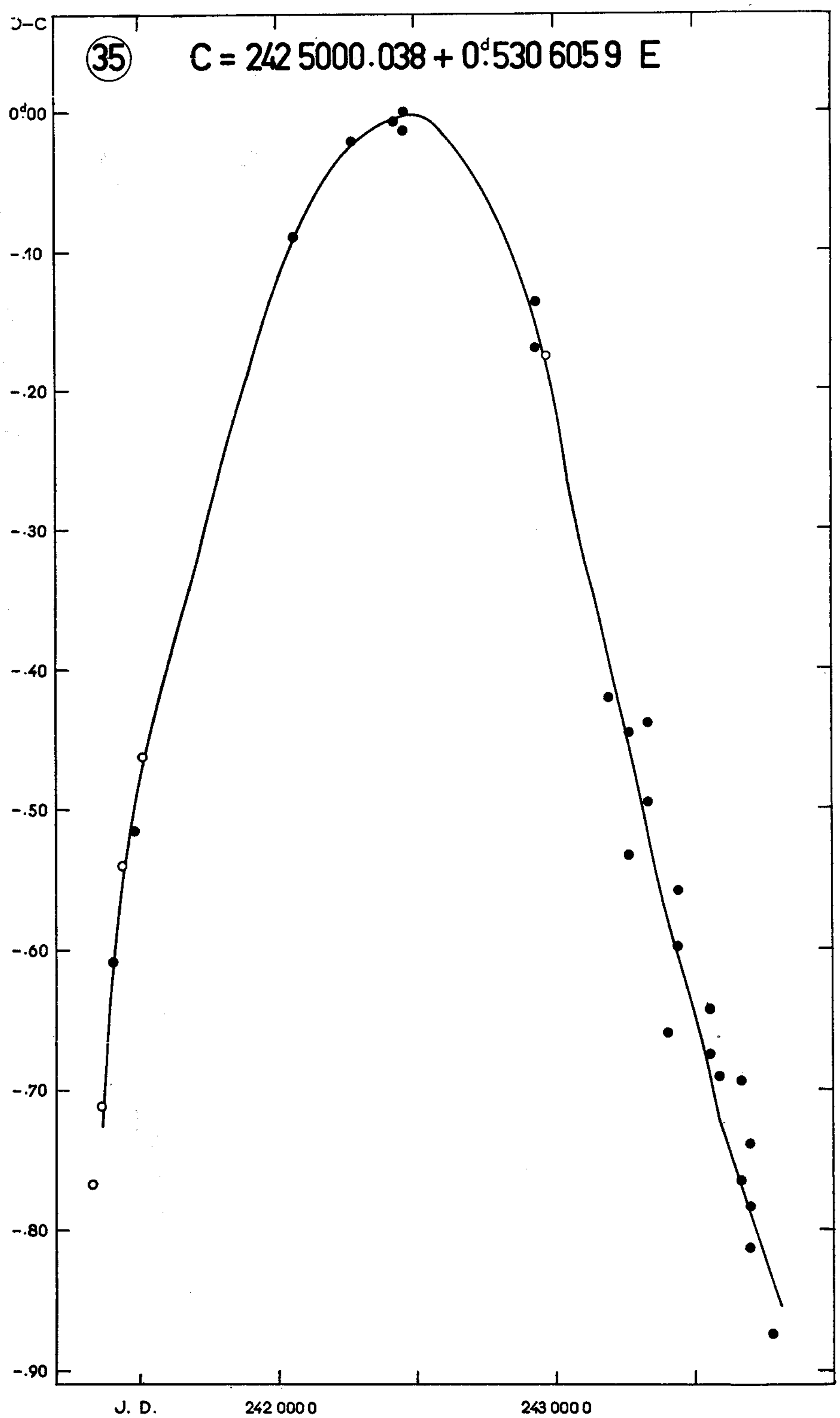

35
C = 242 5000.038 + 0.ᵈ530 605 9 E
O−C
0ᵈ00
−.10
−.20
−.30
−.40
−.50
−.60
−.70
−.80
−.90
J. D.
242 000 0
243 000 0

Fig. 38.

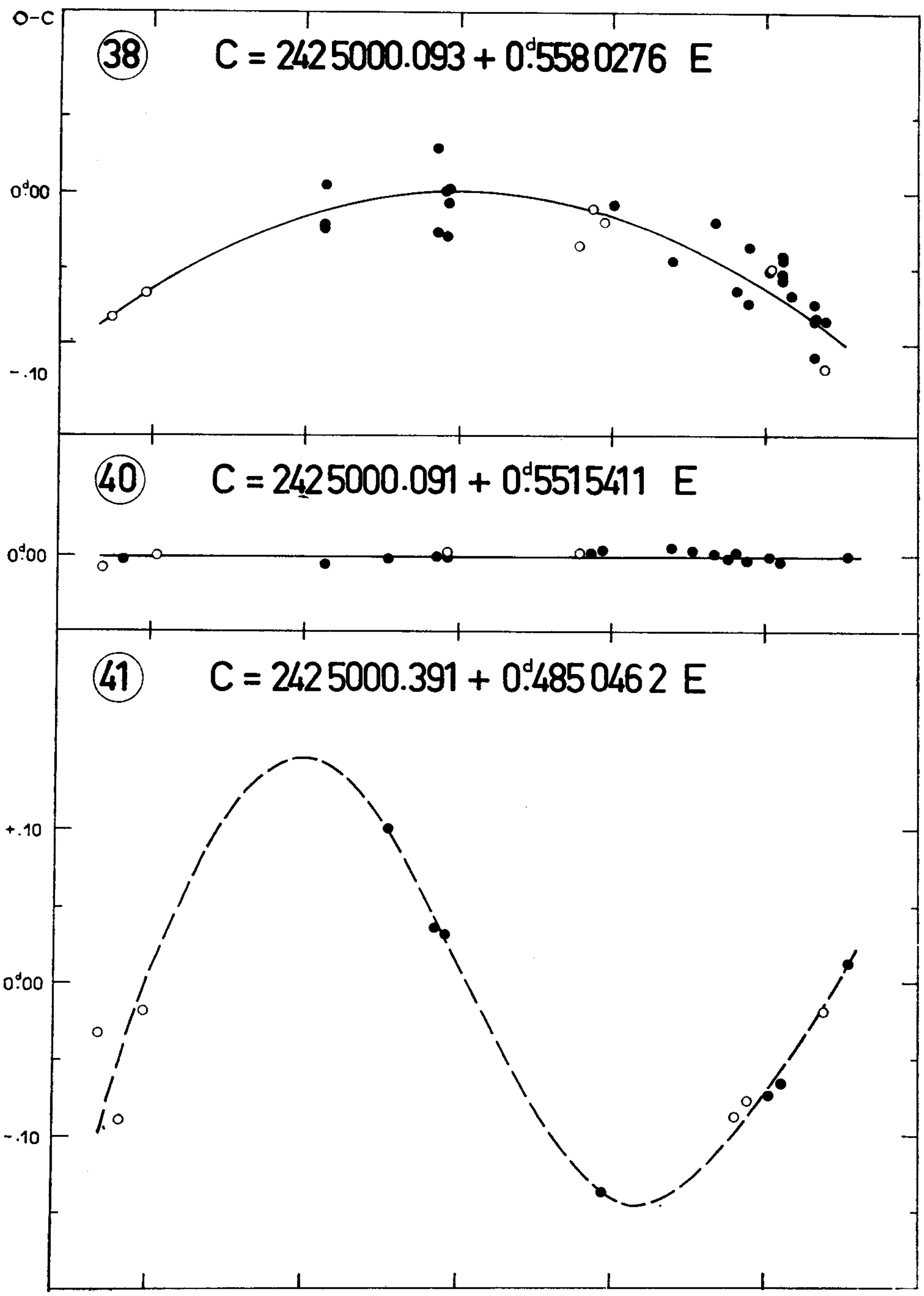

O–C
38
C = 2425000.093 + 0ᵈ.5580276 E
0ᵈ.00
−.10
40
C = 2425000.091 + 0ᵈ.5515411 E
0ᵈ.00
41
C = 2425000.391 + 0ᵈ.4850462 E
+.10
0ᵈ.00
−.10
J. D.
2420000
2430000

Fig. 39.

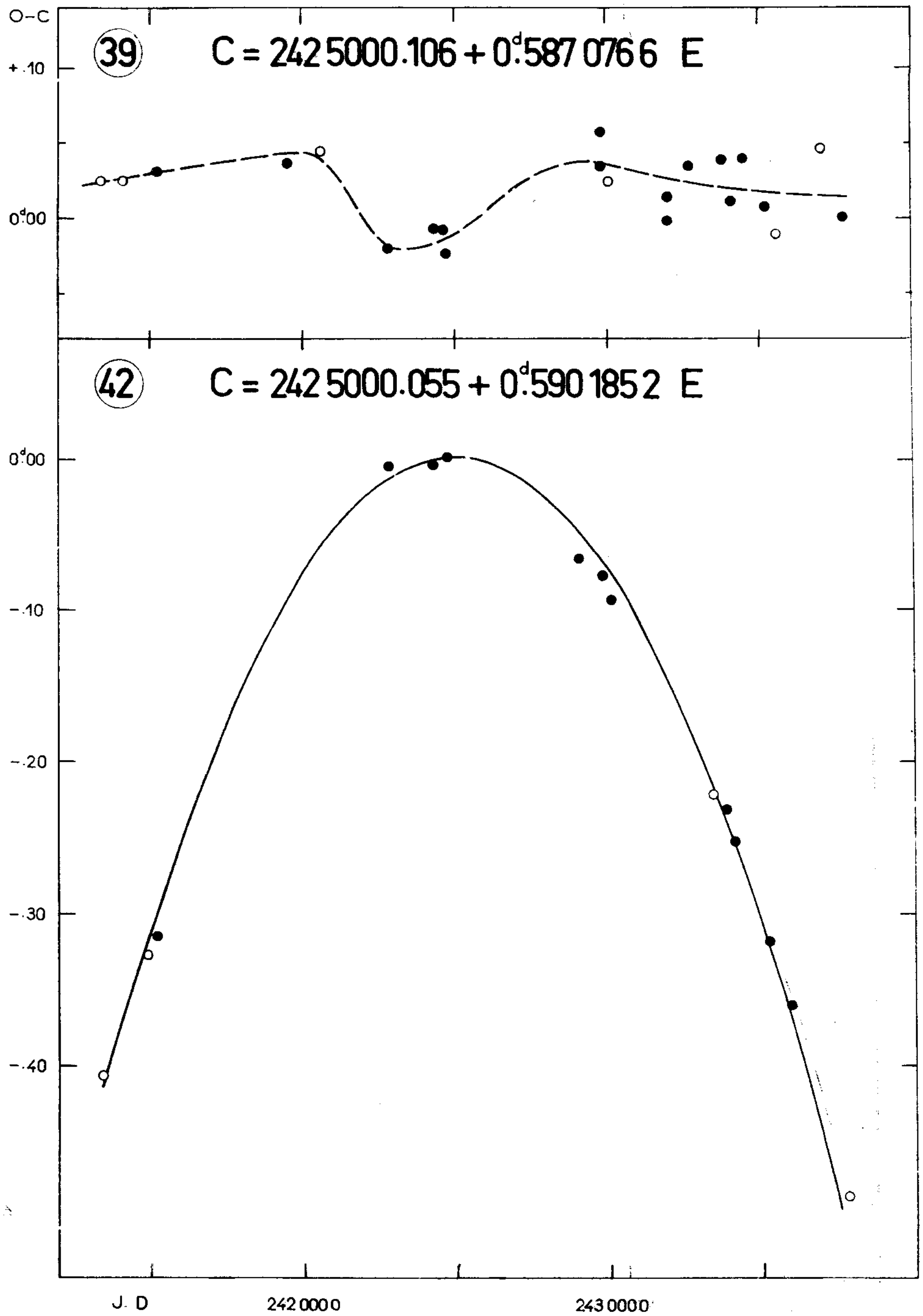
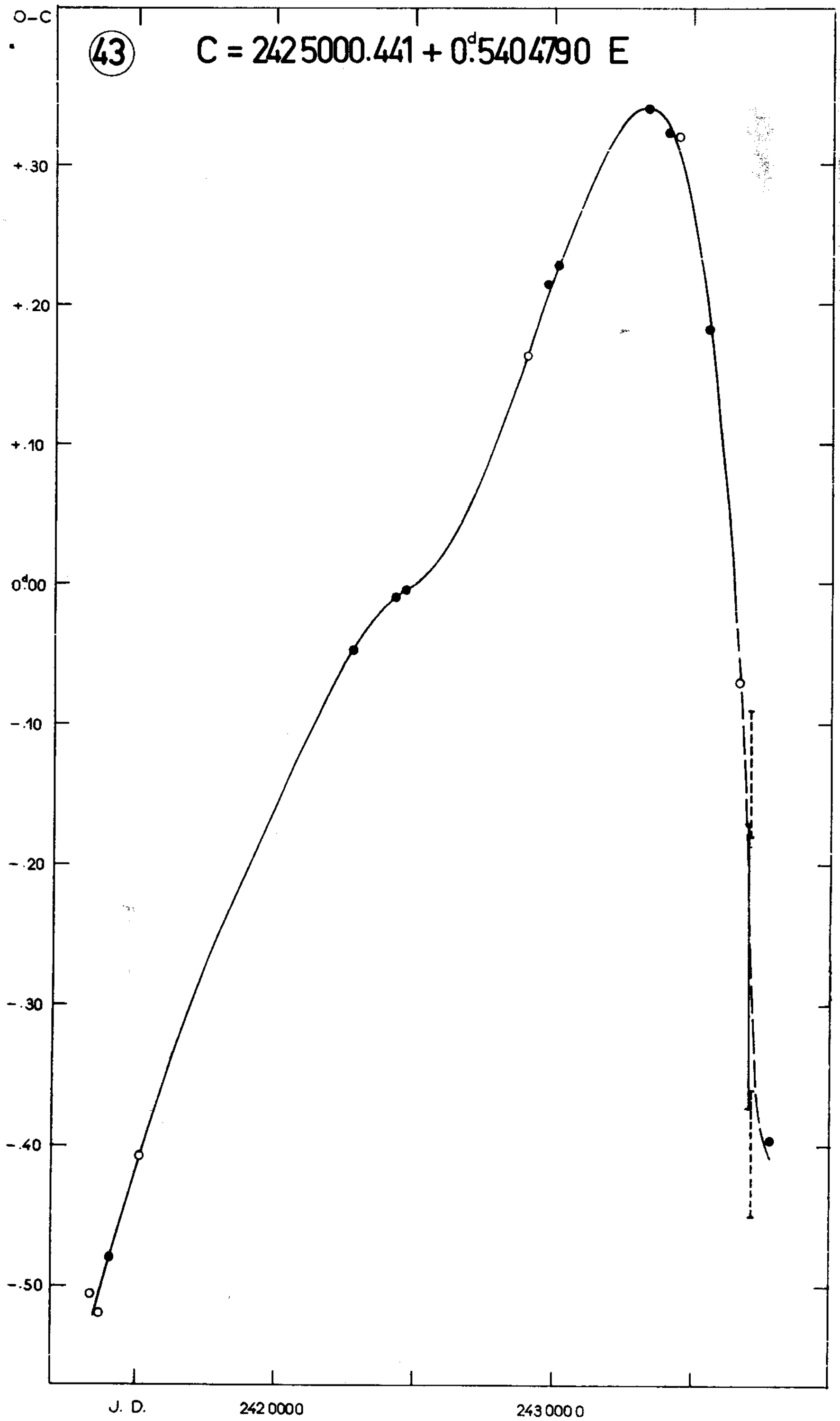

O–C
39
C = 242 5000.106 + 0ᵈ.587 076 6 E
+.10
0ᵈ00
42
C = 242 5000.055 + 0ᵈ.590 185 2 E
0ᵈ00
–.10
–.20
–.30
–.40
J. D
242 0000
243 0000

Fig. 40.



O–C
43
C = 2425000.441 + 0.5404790 E
+.30
+.20
+.10
0.00
−.10
−.20
−.30
−.40
−.50
J. D.
2420000
2430000

Fig. 41.

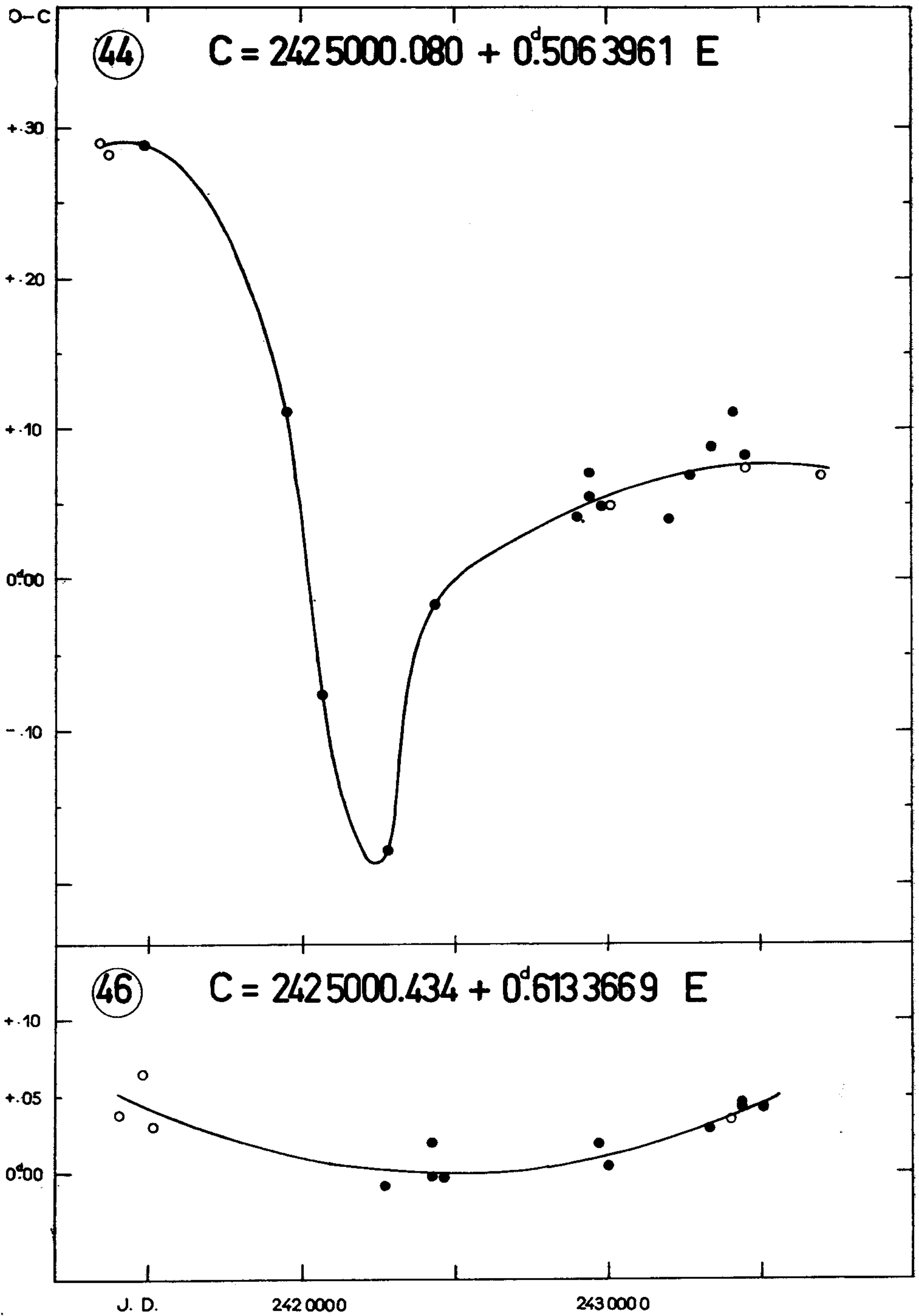

O–C
(44) C = 2425000.080 + 0.ᵈ5063961 E
+.30
+.20
+.10
0.ᵈ00
−.10
(46) C = 2425000.434 + 0.ᵈ6133669 E
+.10
+.05
0.ᵈ00
J. D.
2420000
2430000

Fig. 42.

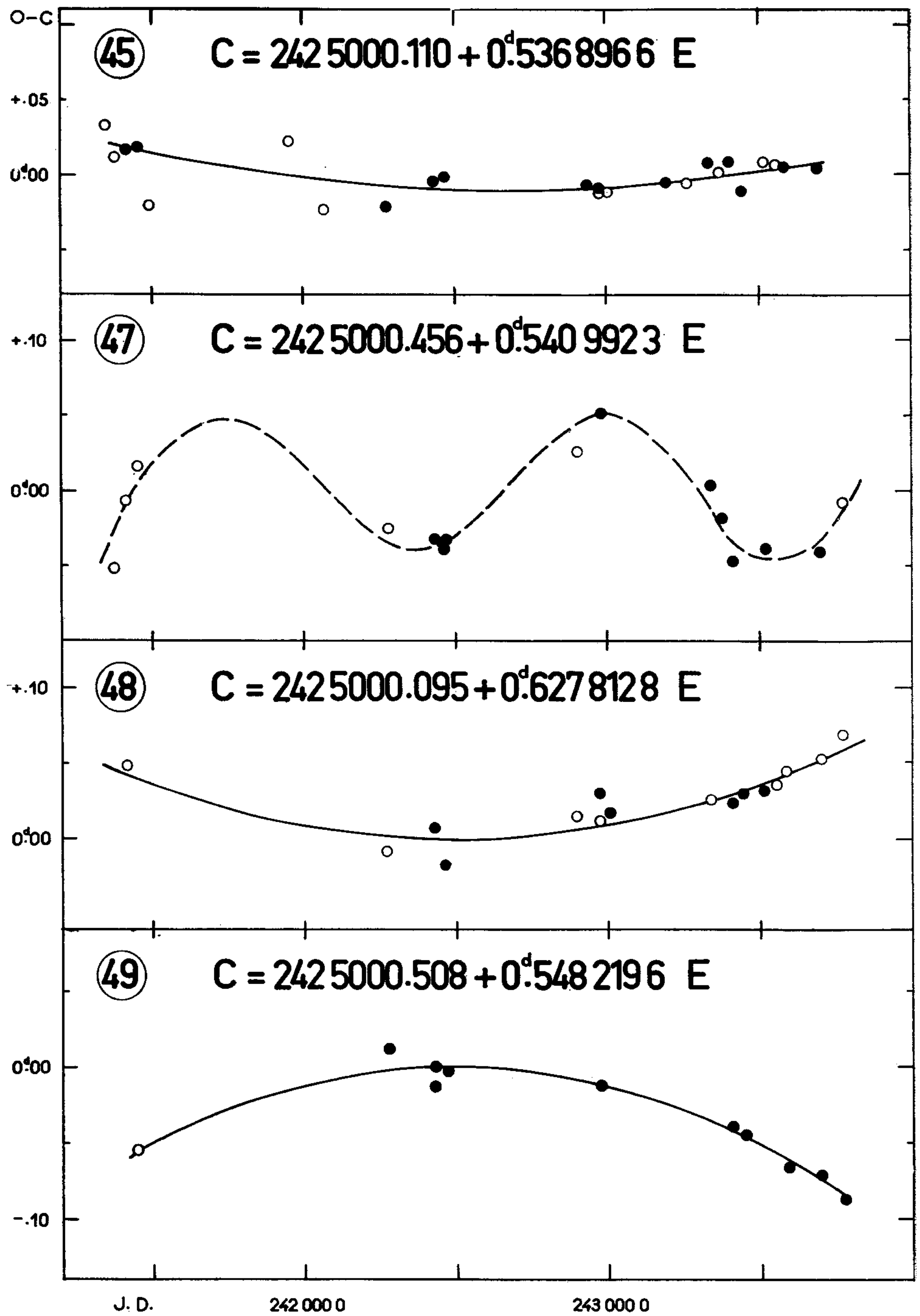

O−C
45
C = 242 5000.110 + 0.ᵈ536 896 6 E
+.05
0.ᵈ00
47
C = 242 5000.456 + 0.ᵈ540 992 3 E
+.10
0.ᵈ00
48
C = 242 5000.095 + 0.ᵈ627 812 8 E
+.10
0.ᵈ00
49
C = 242 5000.508 + 0.ᵈ548 219 6 E
0.ᵈ00
−.10
J. D.
242 000 0
243 000 0

Fig. 43.

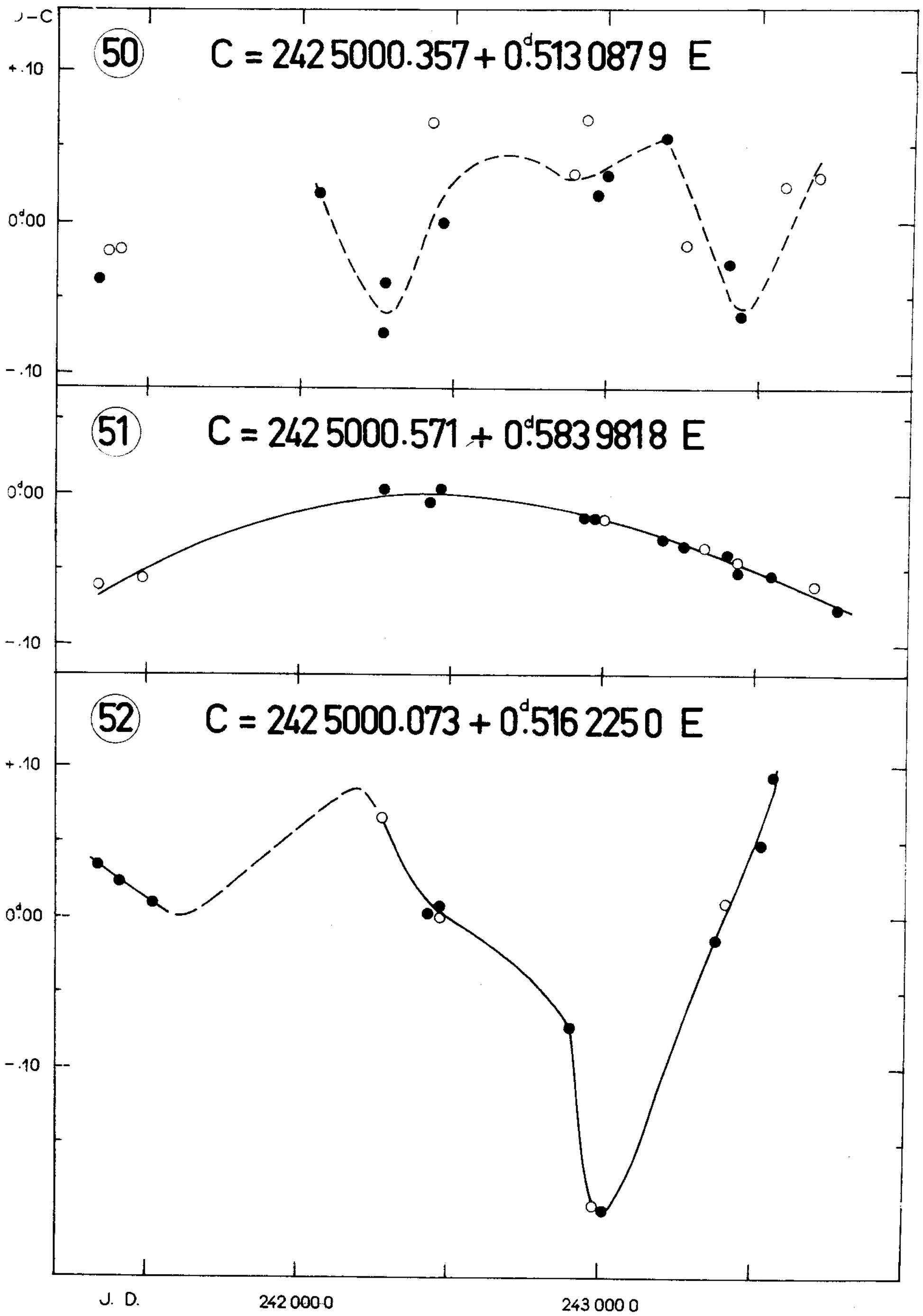

O–C
50
C = 242 5000.357 + 0ᵈ.513 087 9 E
+.10
0ᵈ.00
–.10
51
C = 242 5000.571 + 0ᵈ.583 981 8 E
0ᵈ.00
–.10
52
C = 242 5000.073 + 0ᵈ.516 225 0 E
+.10
0ᵈ.00
–.10
J. D.
242 000 0
243 000 0

Fig. 44.

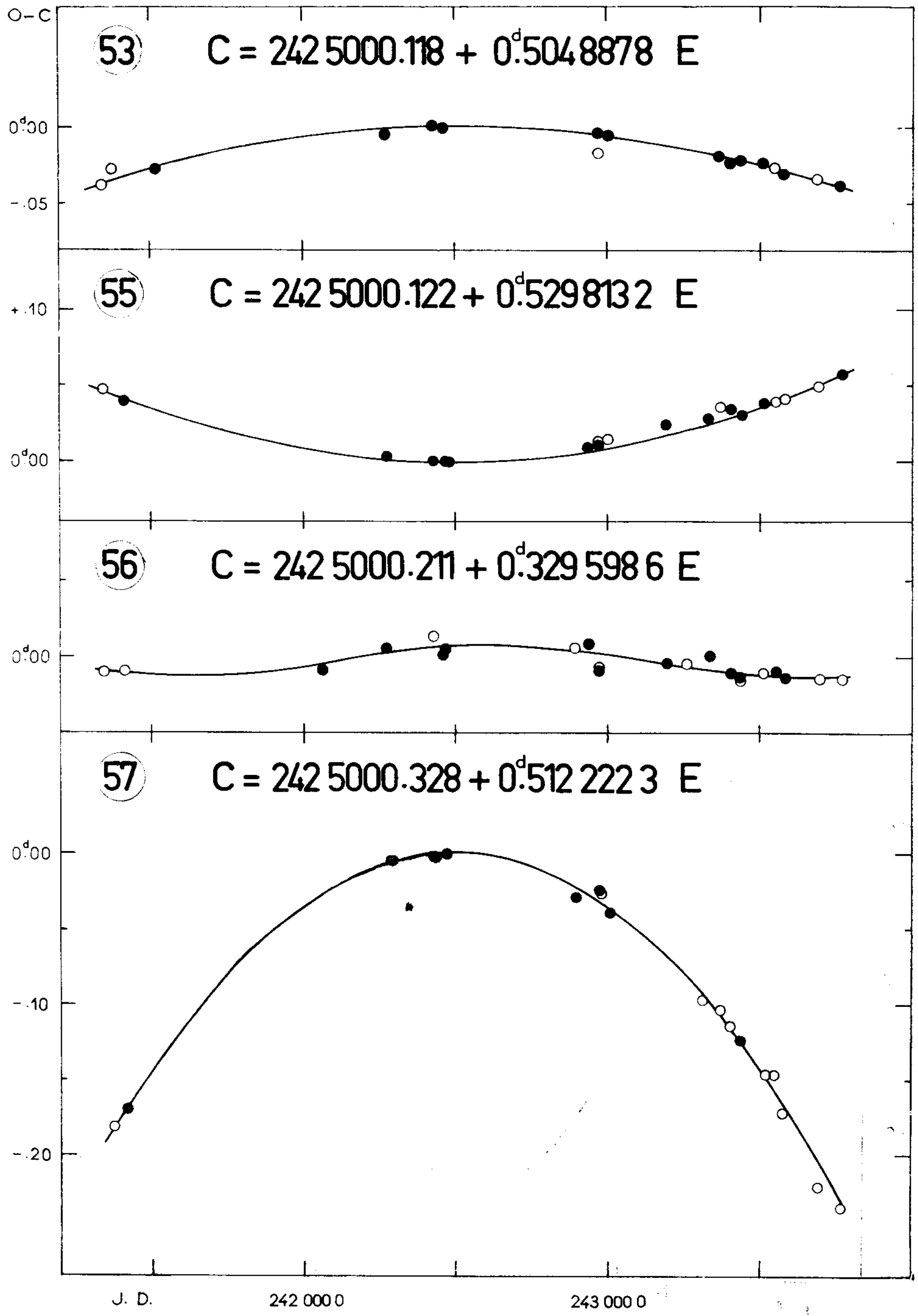

O–C
53
C = 242 5000.118 + 0ᵈ.504 8878 E
0ᵈ.00
–.05
55
C = 242 5000.122 + 0ᵈ.529 813 2 E
+.10
0ᵈ.00
56
C = 242 5000.211 + 0ᵈ.329 598 6 E
0ᵈ.00
57
C = 242 5000.328 + 0ᵈ.512 222 3 E
0ᵈ.00
–.10
–.20
J. D.
242 000 0
243 000 0

Fig. 45.

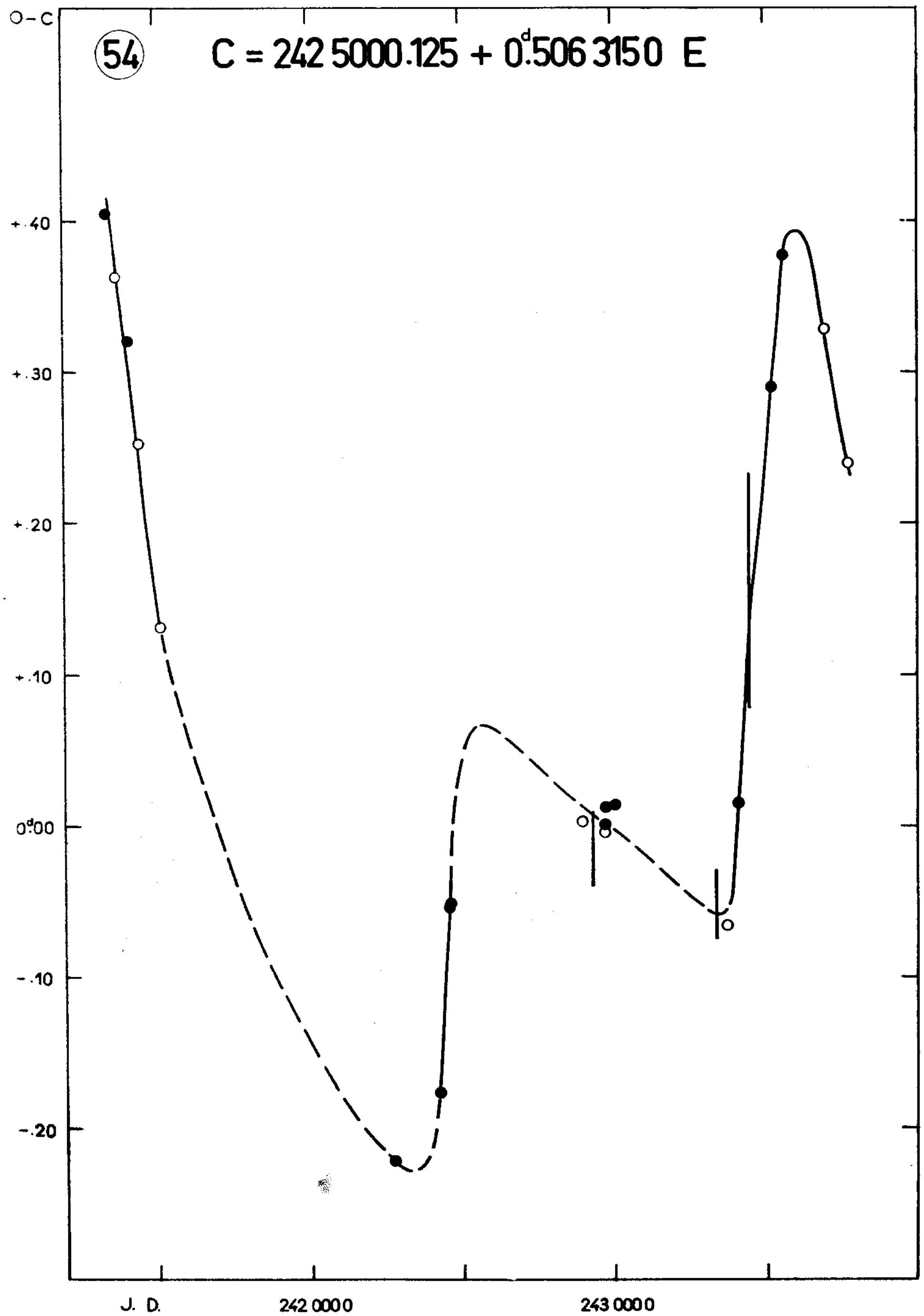

O–C
54
C = 242 5000.125 + 0ᵈ.506 3150 E
+.40
+.30
+.20
+.10
0ᵈ00
–.10
–.20
J. D.
242 0000
243 0000

Fig. 46.

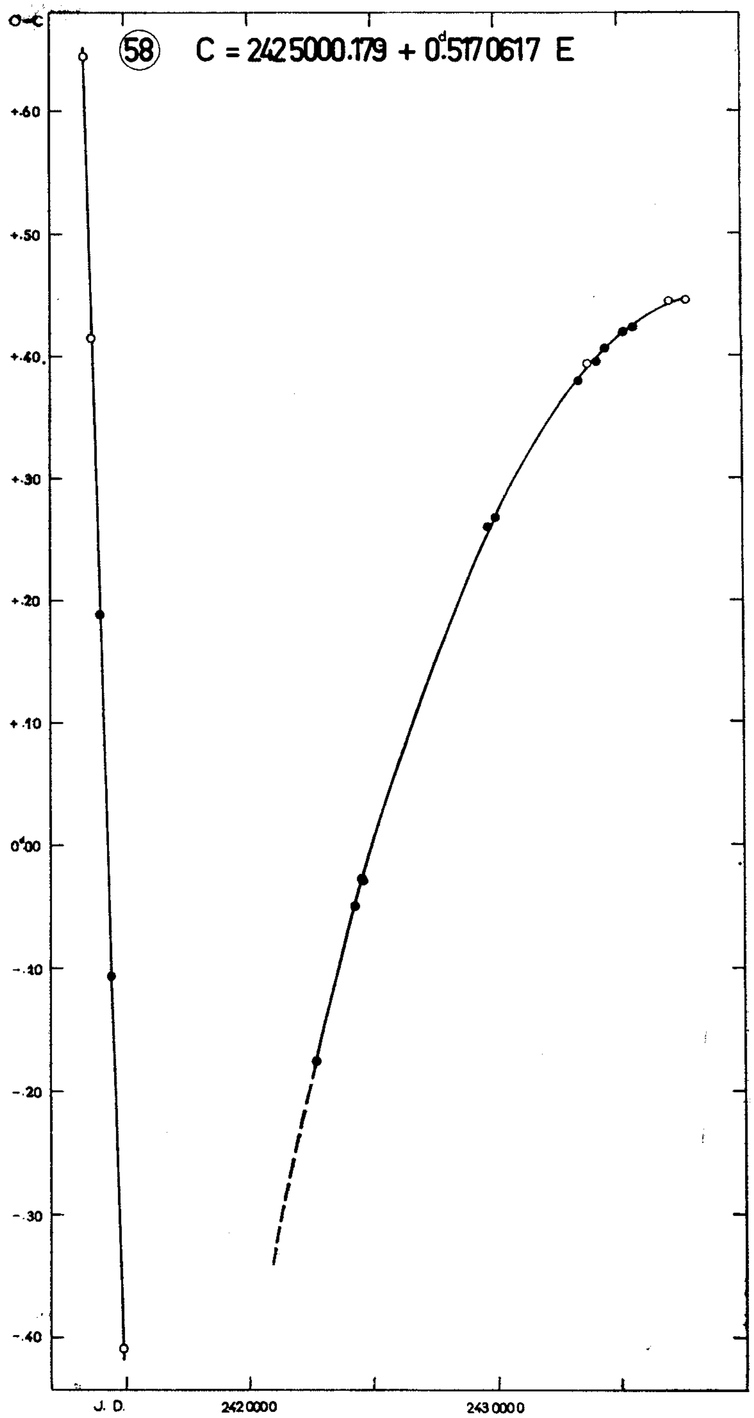

O–C
58
C = 2425000.179 + 0ᵈ.5170617 E
+.60
+.50
+.40
+.30
+.20
+.10
0ᵈ.00
−.10
−.20
−.30
−.40
J. D.
2420000
2430000

Fig. 47.

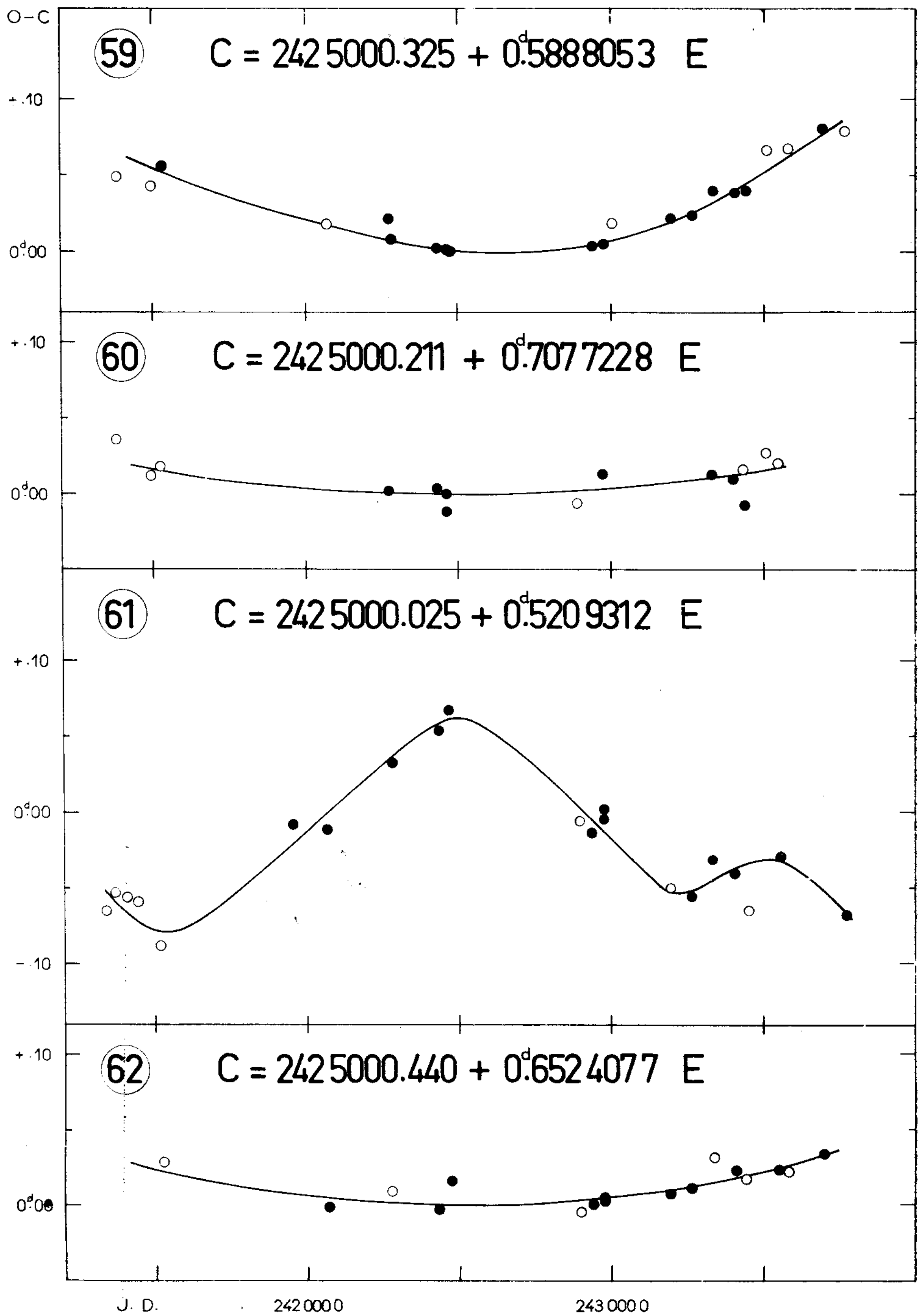

O–C
59
C = 242 5000.325 + 0.ᵈ588 8053 E
+.10
0.ᵈ00
60
C = 242 5000.211 + 0.ᵈ707 7228 E
+.10
0.ᵈ00
61
C = 242 5000.025 + 0.ᵈ520 9312 E
+.10
0.ᵈ00
–.10
62
C = 242 5000.440 + 0.ᵈ652 4077 E
+.10
0.ᵈ00
J. D.
242 0000
243 0000

Fig. 48.

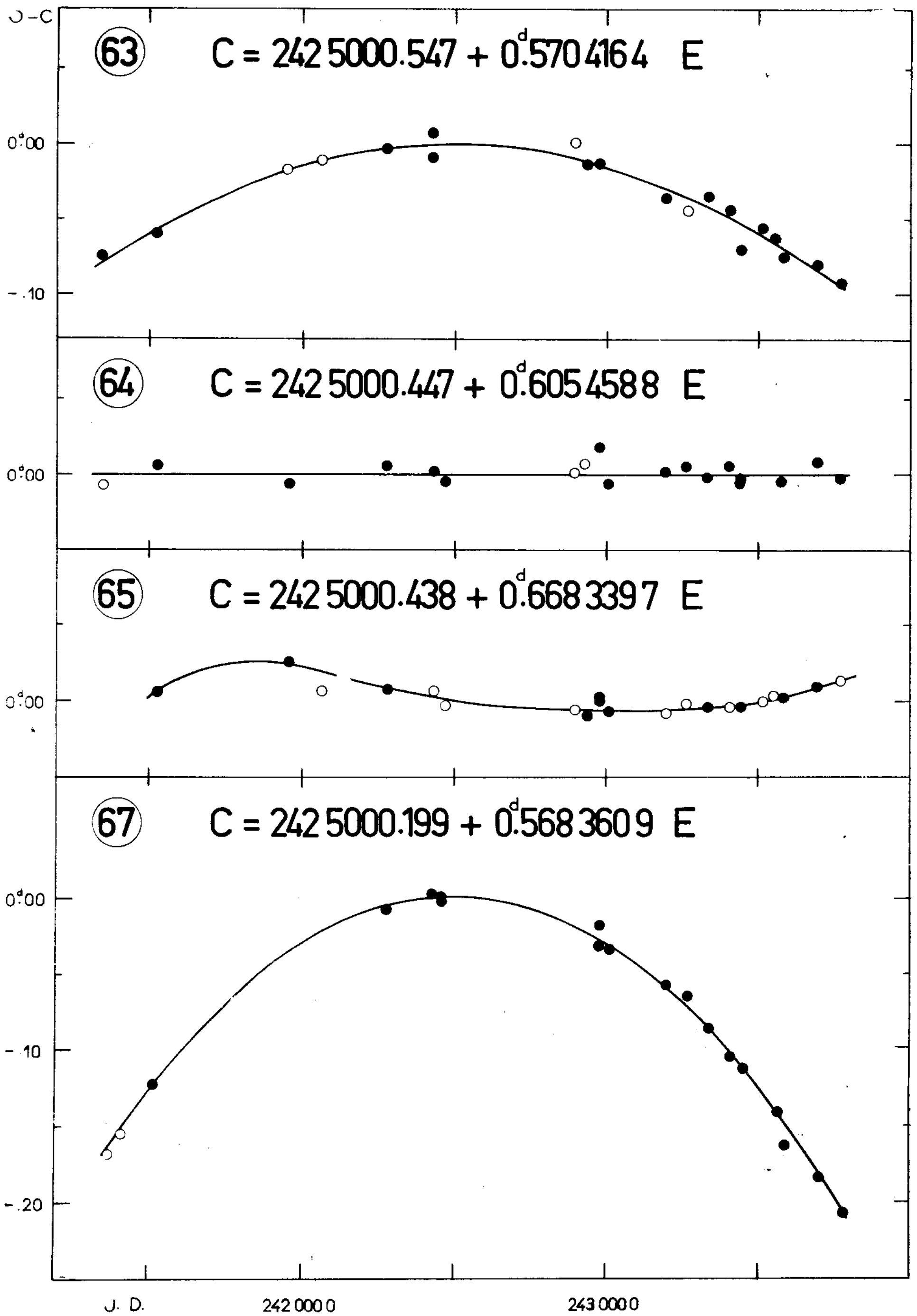

O – C
63
C = 242 5000.547 + 0.ᵈ570 4164 E
0.ᵈ00
–.10
64
C = 242 5000.447 + 0.ᵈ605 4588 E
0.ᵈ00
65
C = 242 5000.438 + 0.ᵈ668 3397 E
0.ᵈ00
67
C = 242 5000.199 + 0.ᵈ568 3609 E
0.ᵈ00
–.10
–.20
J. D.
242 0000
243 0000

Fig. 49.

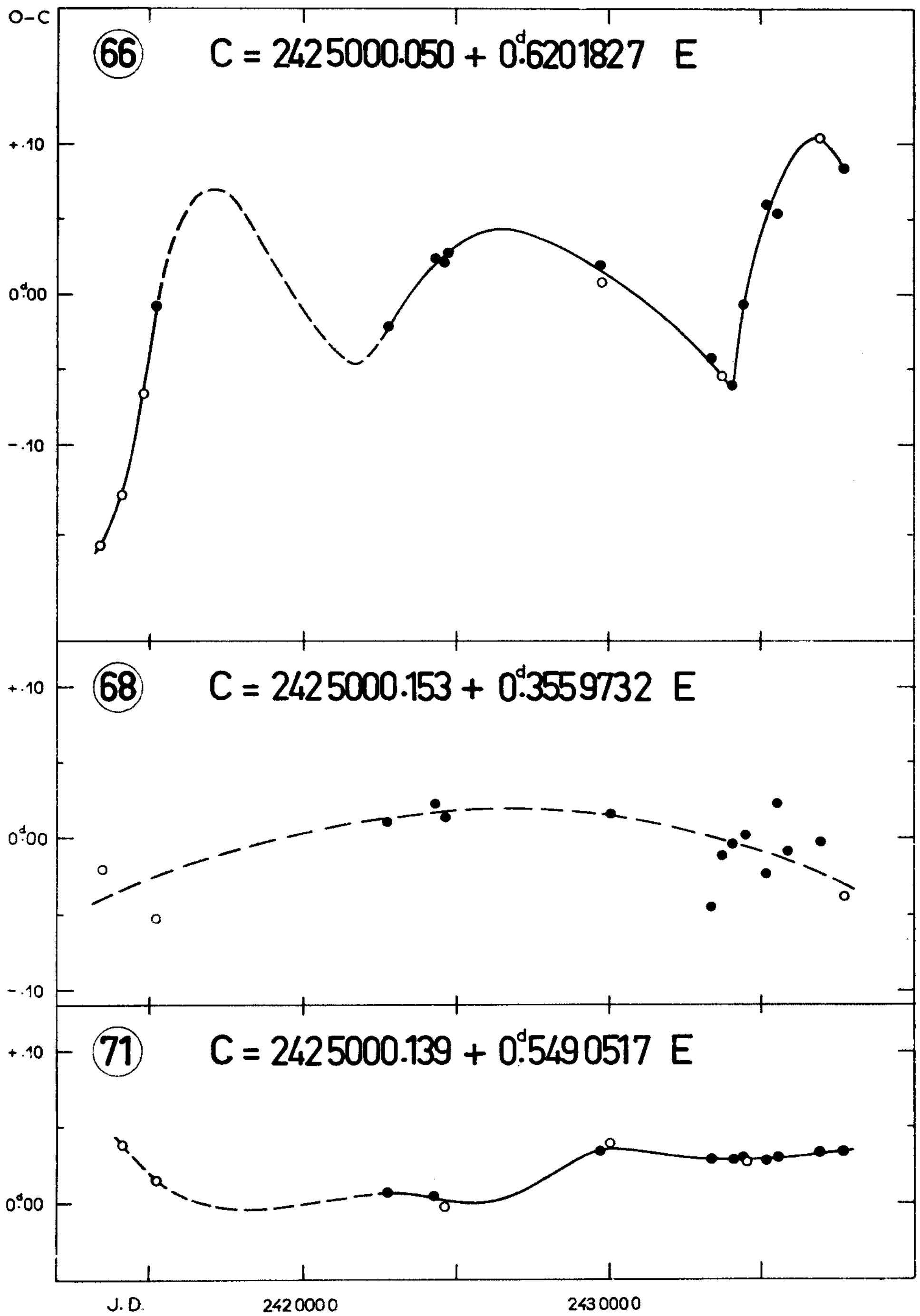

O–C
66
C = 2425000.050 + 0.d6201827 E
+.10
0.d00
−.10
68
C = 2425000.153 + 0.d3559732 E
+.10
0.d00
−.10
71
C = 2425000.139 + 0.d5490517 E
+.10
0.d00
J. D.
2420000
2430000

Fig. 50.

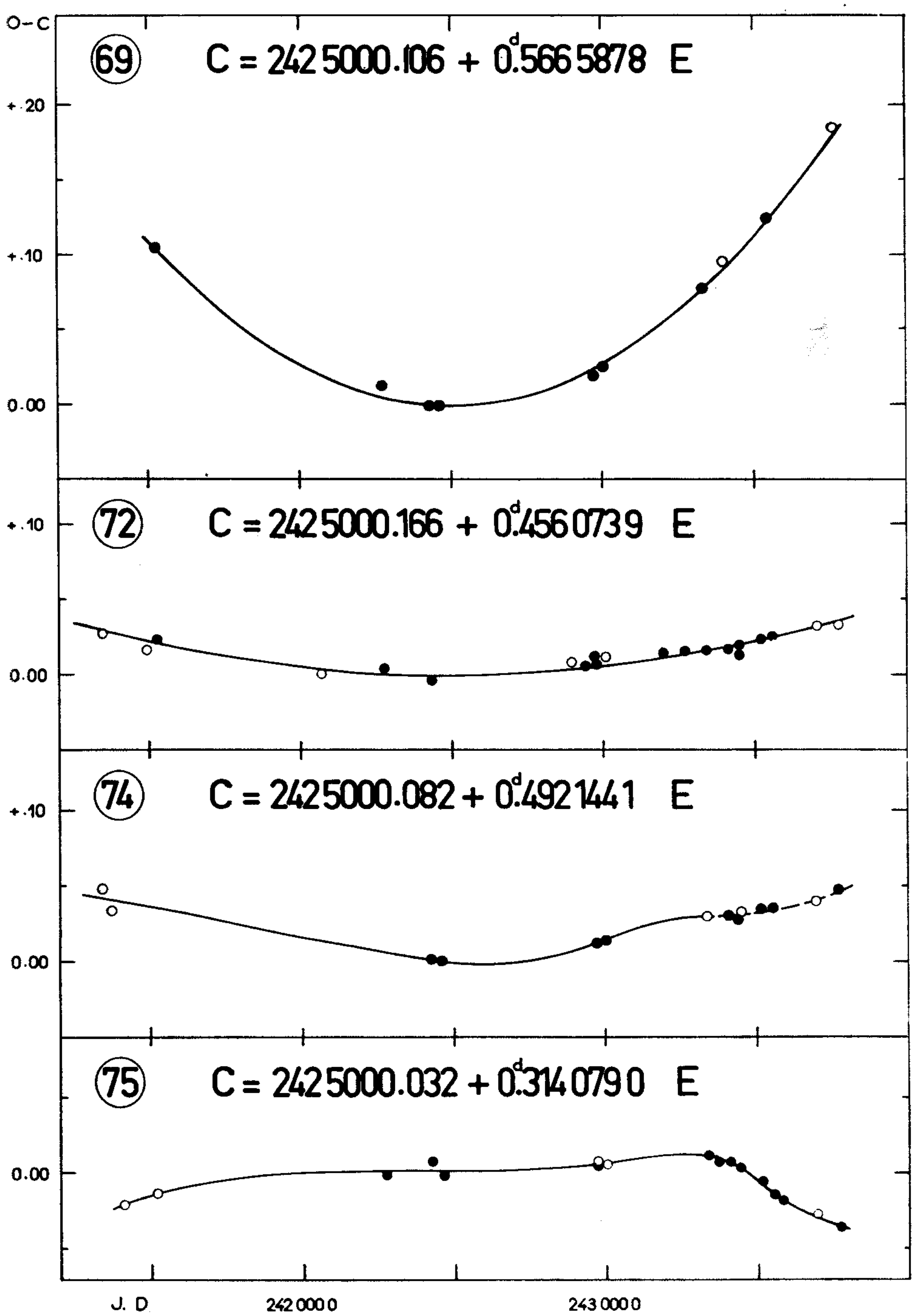
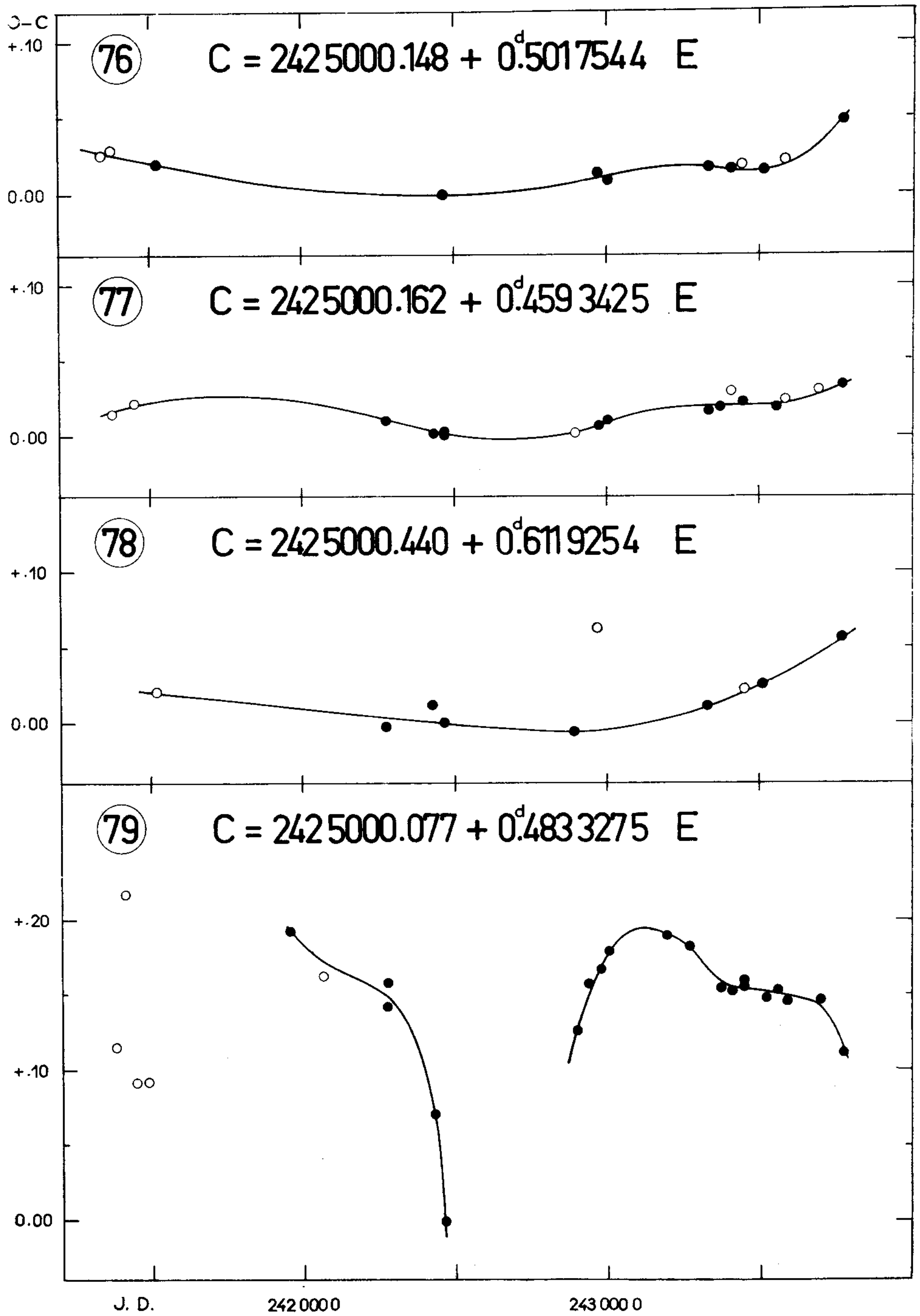

O–C
69
C = 2425000.106 + 0.^{d}5665878 E
+.20
+.10
0.00
72
C = 2425000.166 + 0.^{d}4560739 E
+.10
0.00
74
C = 2425000.082 + 0.^{d}4921441 E
+.10
0.00
75
C = 2425000.032 + 0.^{d}3140790 E
0.00
J. D
2420000
2430000

Fig. 51.



O–C
+.10
0.00
(76)
C = 2425000.148 + 0ᵈ.5017544 E
+.10
0.00
(77)
C = 2425000.162 + 0ᵈ.4593425 E
+.10
0.00
(78)
C = 2425000.440 + 0ᵈ.6119254 E
+.20
+.10
0.00
(79)
C = 2425000.077 + 0ᵈ.4833275 E
J. D.
2420000
2430000

Fig. 52.

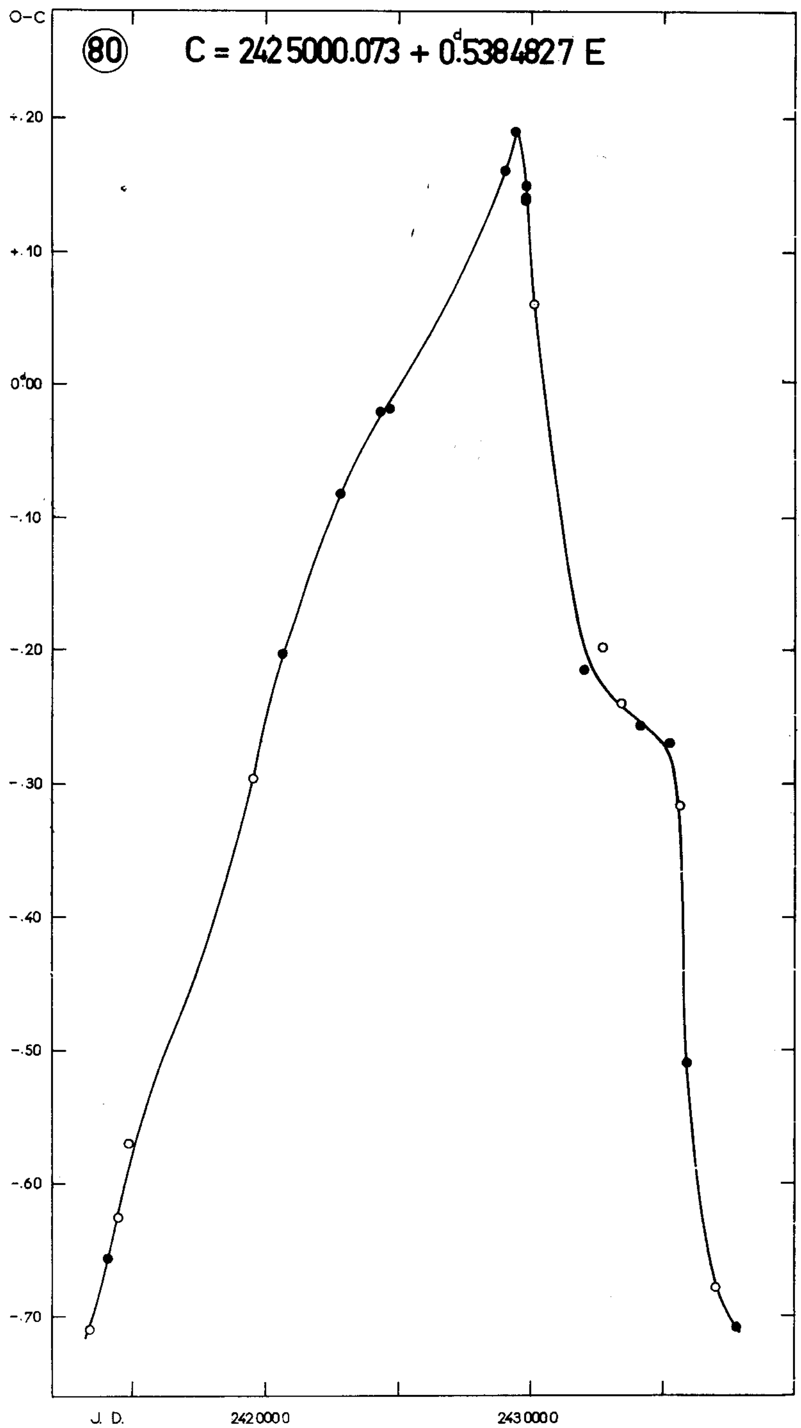

O–C
80
C = 2425000.073 + 0.d5384827 E
+.20
+.10
0.d00
–.10
–.20
–.30
–.40
–.50
–.60
–.70
J. D.
2420000
2430000

Fig. 53.

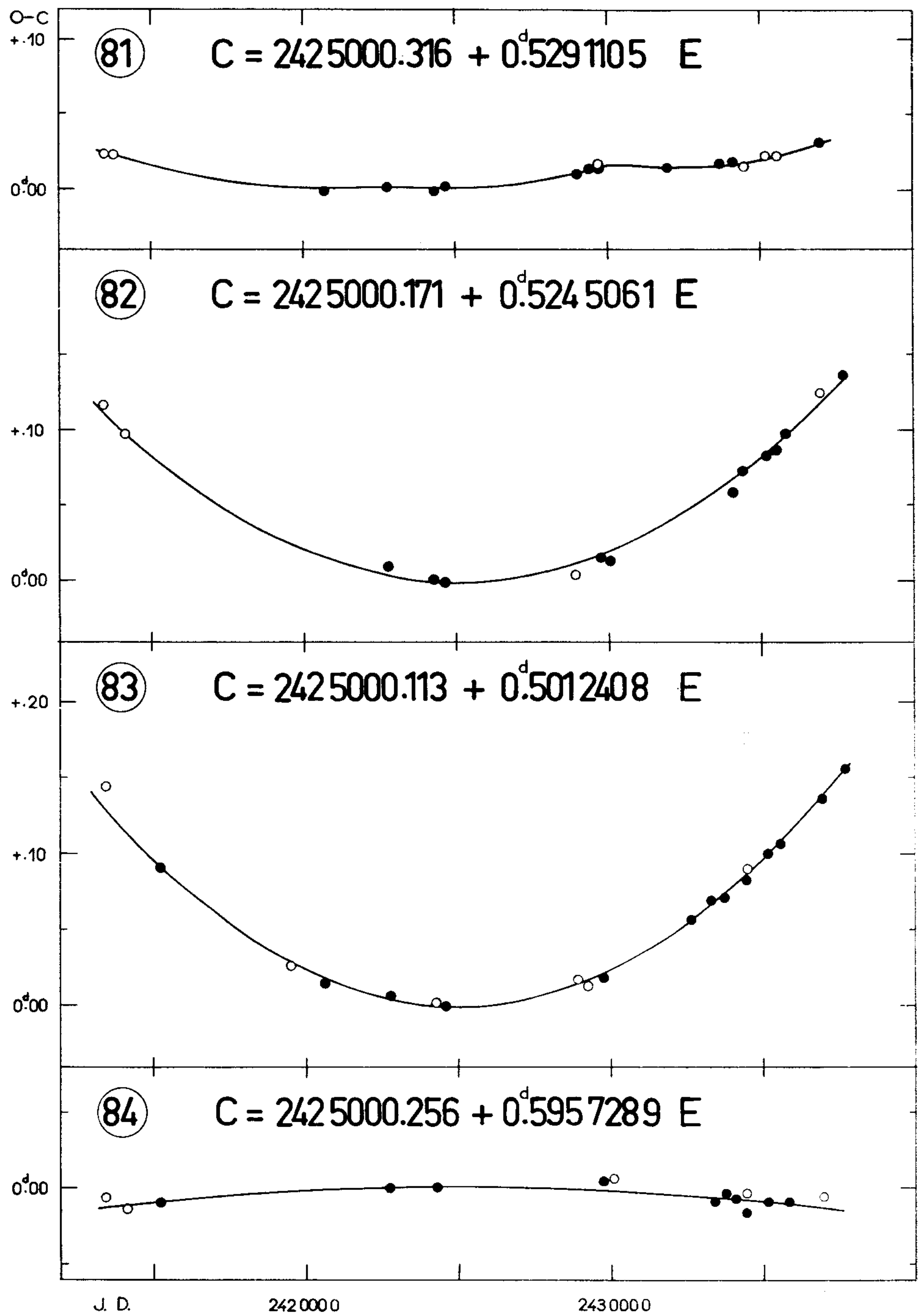

O–C
+.10
81
C = 2425000.316 + 0.ᵈ5291105 E
0.ᵈ00
82
C = 2425000.171 + 0.ᵈ5245061 E
+.10
0.ᵈ00
83
C = 2425000.113 + 0.ᵈ5012408 E
+.20
+.10
0.ᵈ00
84
C = 2425000.256 + 0.ᵈ5957289 E
0.ᵈ00
J. D.
2420000
2430000

Fig. 54.

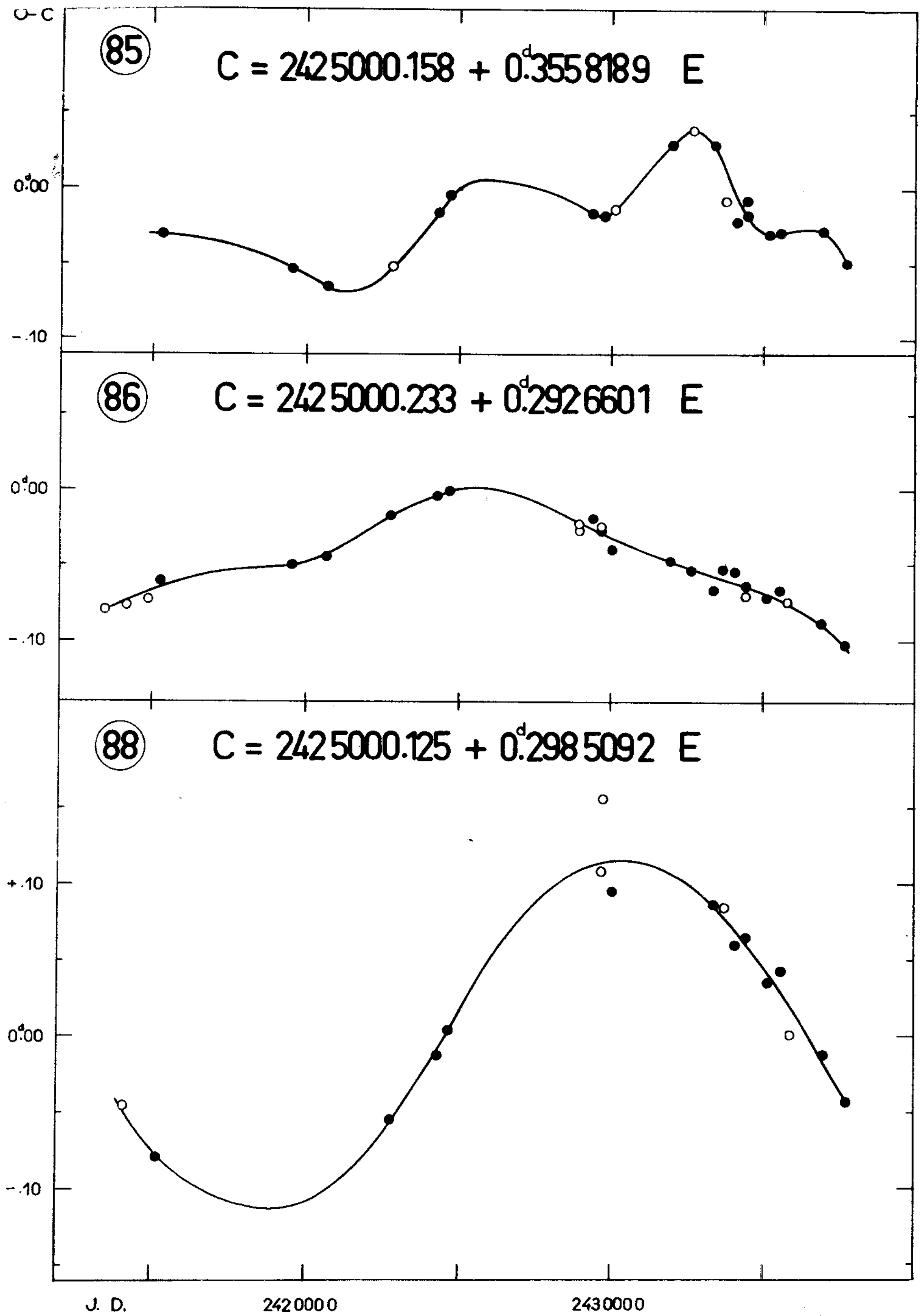

O–C
85
C = 2425000.158 + 0.^{d}3558189 E
0.^{d}00
–.10
86
C = 2425000.233 + 0.^{d}2926601 E
0.^{d}00
–.10
88
C = 2425000.125 + 0.^{d}2985092 E
+.10
0.^{d}00
–.10
J. D.
2420000
2430000

Fig. 55.

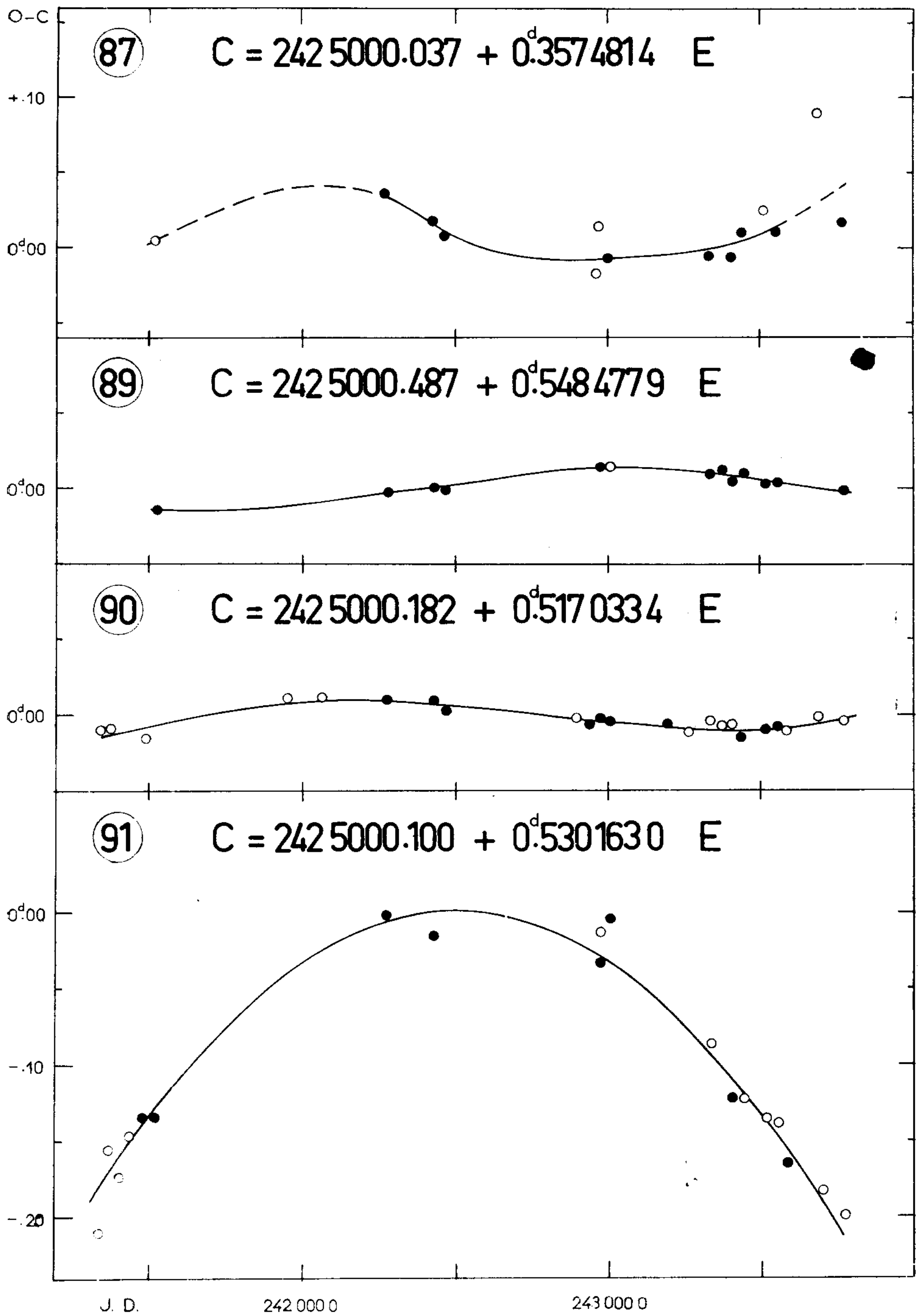

O–C
87
C = 242 5000.037 + 0.^{d}3574814 E
+.10
0.^{d}00
89
C = 242 5000.487 + 0.^{d}5484779 E
0.^{d}00
90
C = 242 5000.182 + 0.^{d}5170334 E
0.^{d}00
91
C = 242 5000.100 + 0.^{d}5301630 E
0.^{d}00
–.10
–.20
J. D.
242 000 0
243 000 0

Fig. 56.

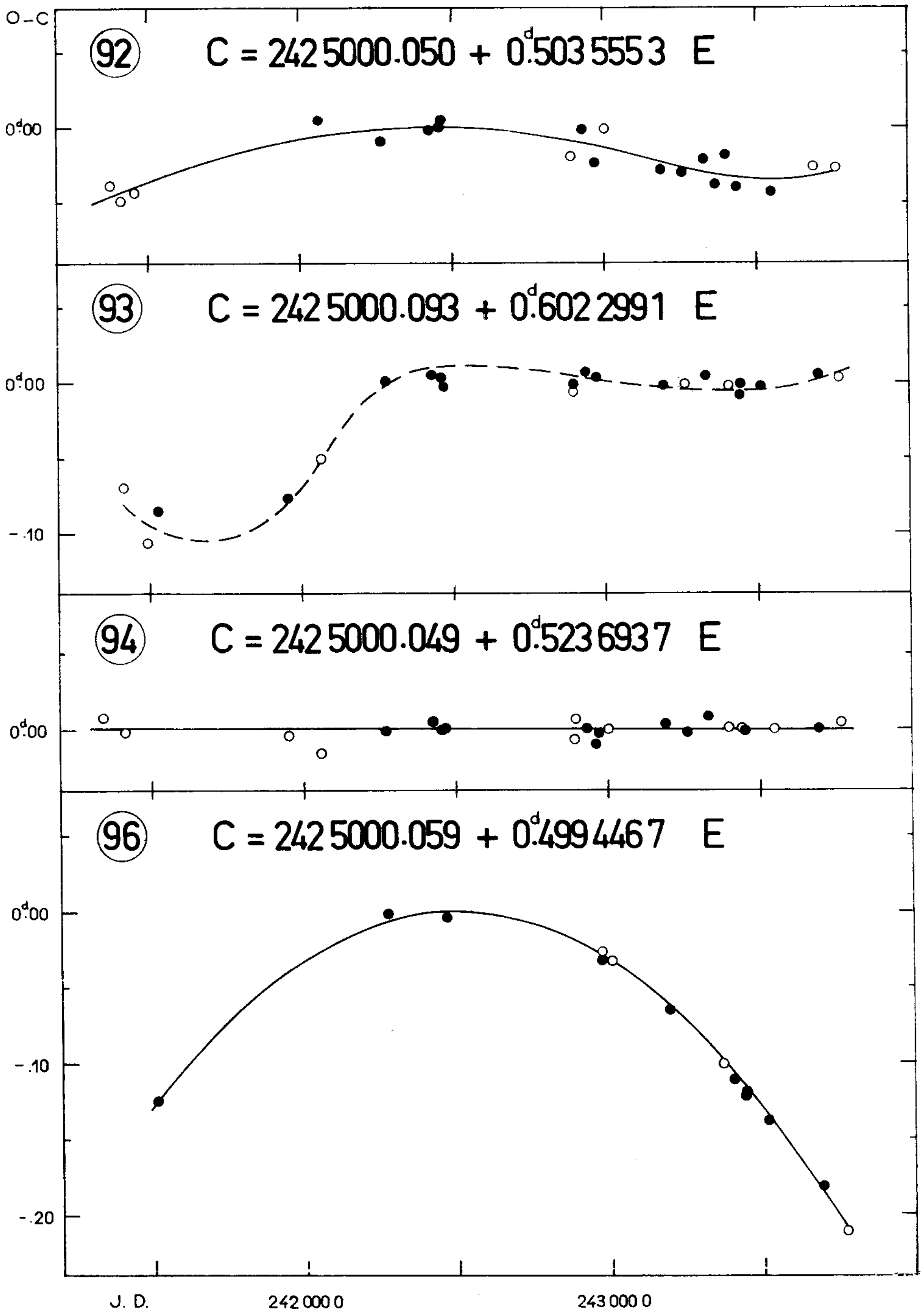

O–C
92
C = 242 5000.050 + 0.^{d}503 555 3 E
0.^{d}00
93
C = 242 5000.093 + 0.^{d}602 2991 E
0.^{d}00
-.10
94
C = 242 5000.049 + 0.^{d}523 693 7 E
0.^{d}00
96
C = 242 5000.059 + 0.^{d}499 446 7 E
0.^{d}00
-.10
-.20
J. D.
242 000 0
243 000 0

Fig. 57.

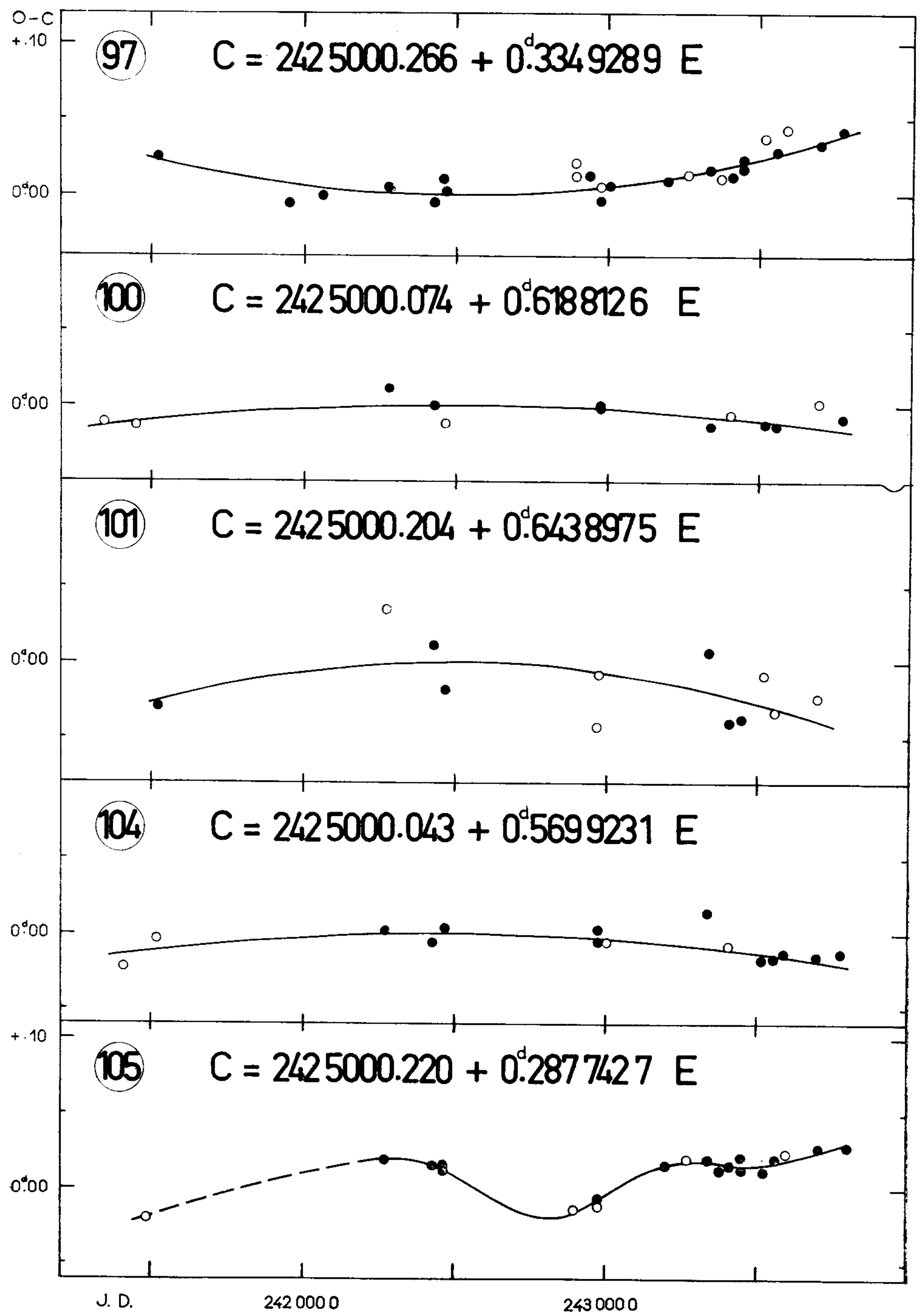

O–C
+.10
97
C = 2425000.266 + 0.^{d}3349289 E
0.^{d}00
100
C = 2425000.074 + 0.^{d}6188126 E
0.^{d}00
101
C = 2425000.204 + 0.^{d}6438975 E
0.^{d}00
104
C = 2425000.043 + 0.^{d}5699231 E
0.^{d}00
+.10
105
C = 2425000.220 + 0.^{d}2877427 E
0.^{d}00
J. D.
2420000
2430000

Fig. 58.

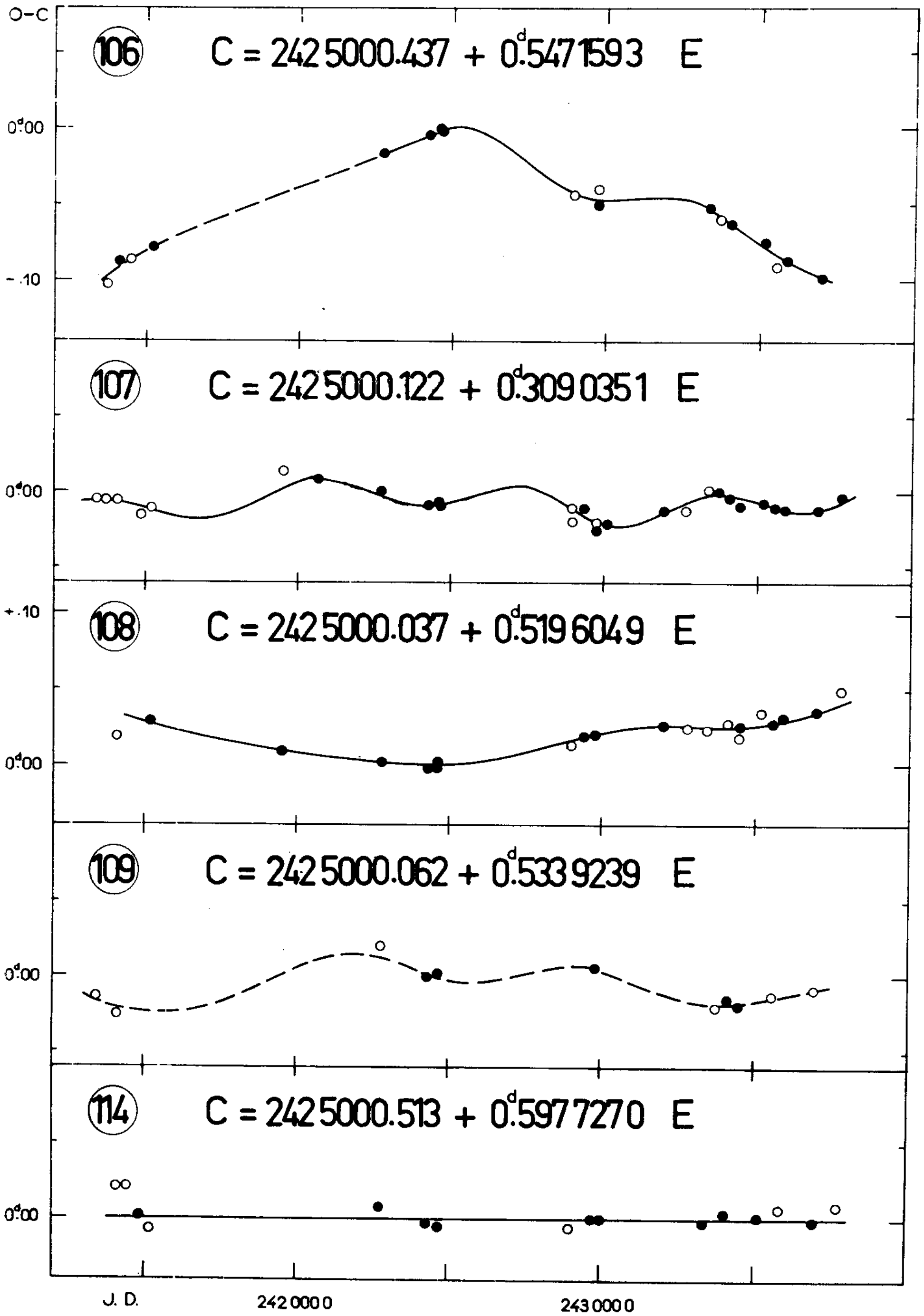

O−C
106
C = 2425000.437 + 0.5471593 E
0.00
−.10
107
C = 2425000.122 + 0.3090351 E
0.00
+.10
108
C = 2425000.037 + 0.5196049 E
0.00
109
C = 2425000.062 + 0.5339239 E
0.00
114
C = 2425000.513 + 0.5977270 E
0.00
J. D.
2420000
2430000

Fig. 59.

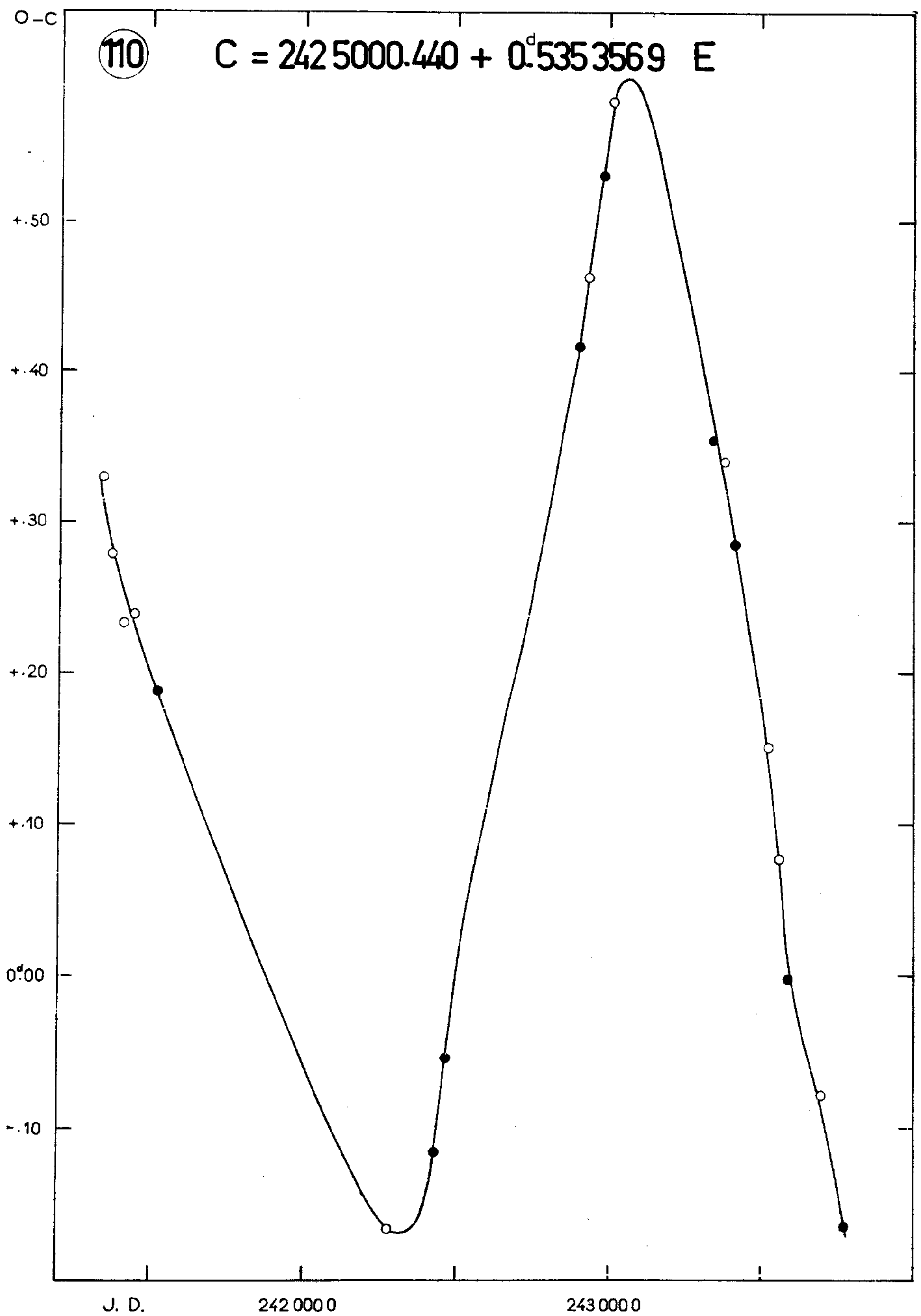

O–C
110
C = 2425000.440 + 0.^{d}5353569 E
+.50
+.40
+.30
+.20
+.10
0.^{d}00
–.10
J. D.
2420000
2430000

Fig. 60.

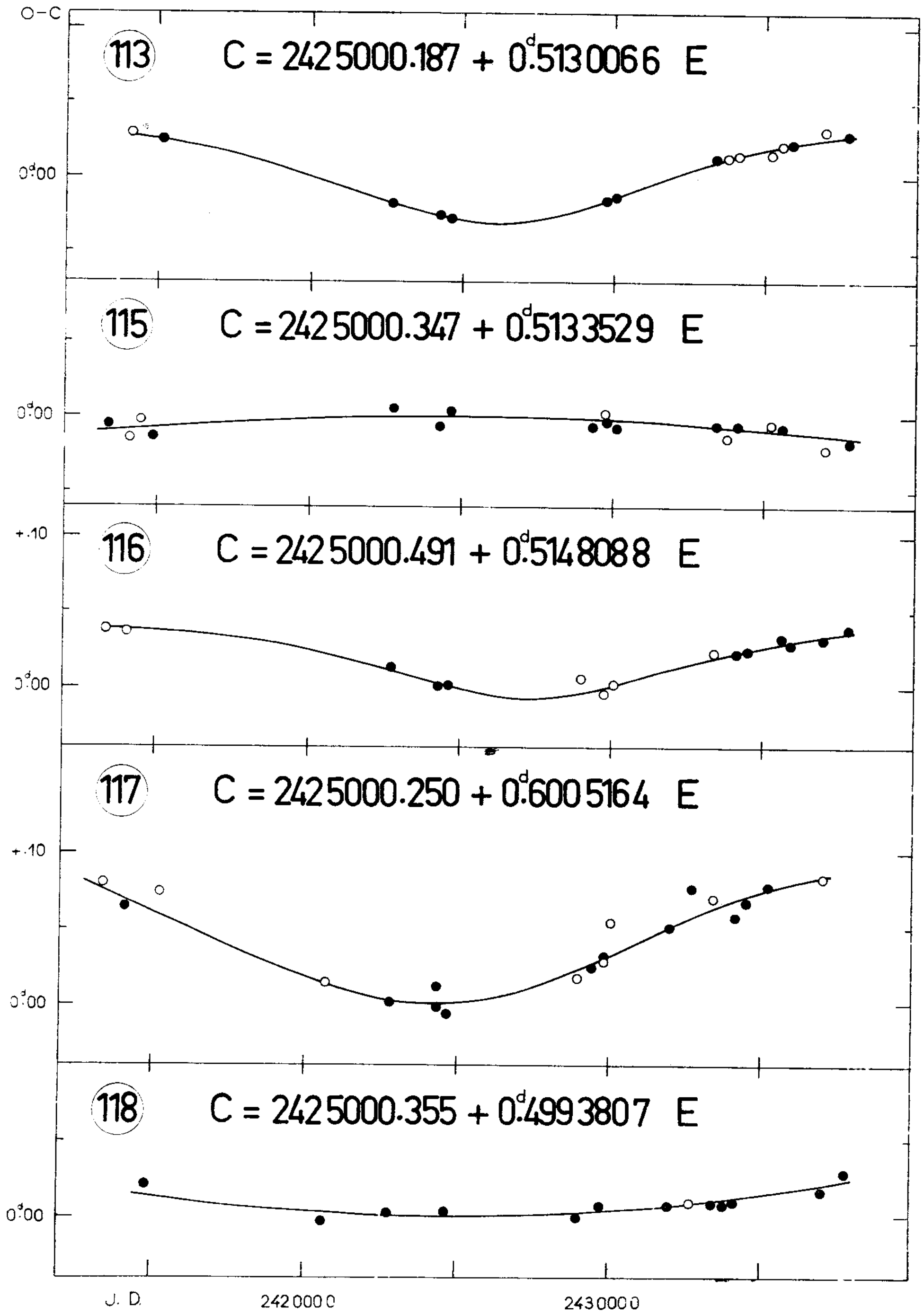

O–C
113
C = 2425000.187 + 0ᵈ.5130066 E
0ᵈ00
115
C = 2425000.347 + 0ᵈ.5133529 E
0ᵈ00
+.10
116
C = 2425000.491 + 0ᵈ.5148088 E
0ᵈ00
117
C = 2425000.250 + 0ᵈ.6005164 E
+.10
0ᵈ00
118
C = 2425000.355 + 0ᵈ.4993807 E
0ᵈ00
J. D.
2420000
2430000

Fig. 61.

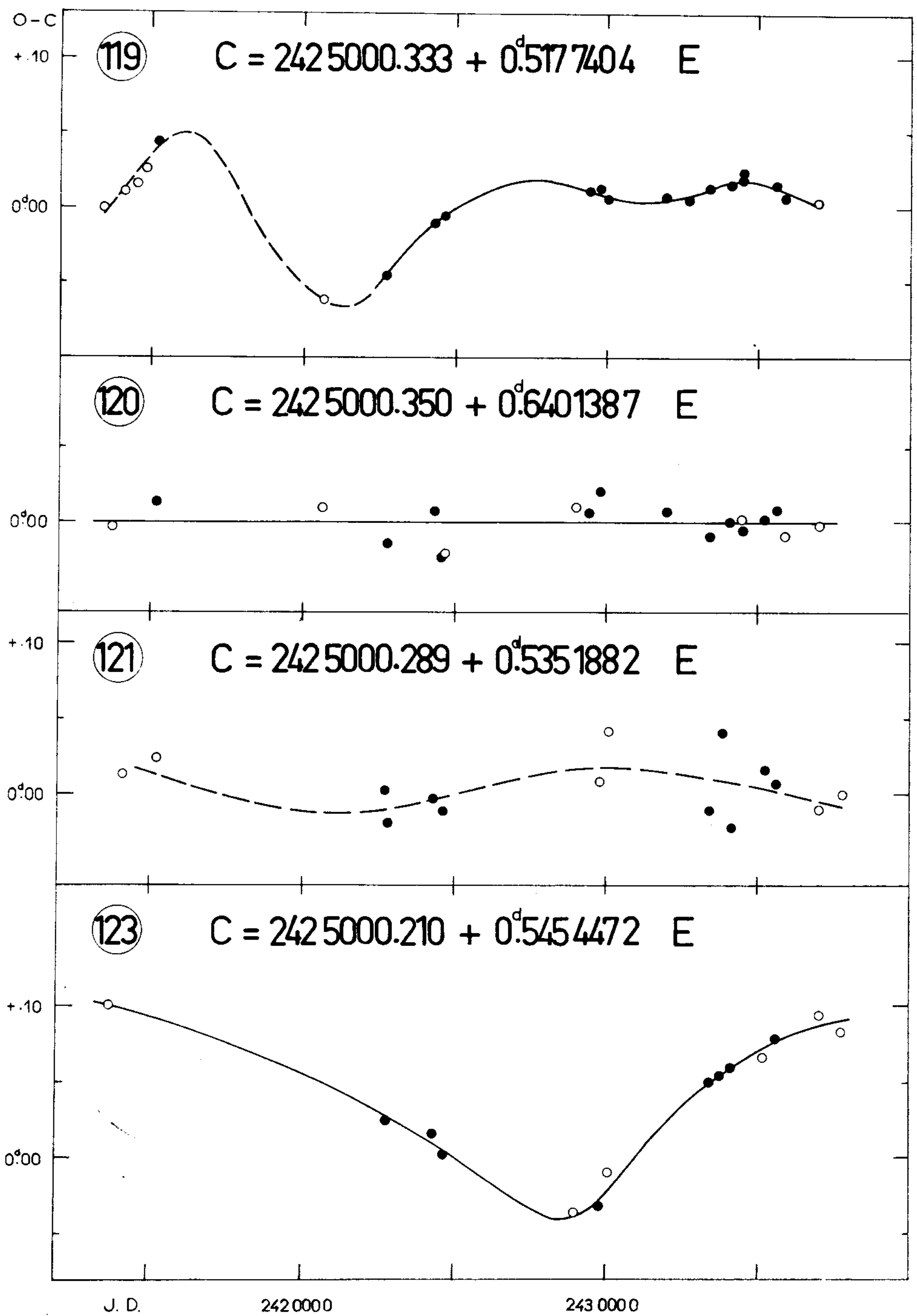

O−C
+.10
119
C = 2425000.333 + 0ᵈ.5177404 E
0ᵈ.00
120
C = 2425000.350 + 0ᵈ.6401387 E
0ᵈ.00
+.10
121
C = 2425000.289 + 0ᵈ.5351882 E
0ᵈ.00
123
C = 2425000.210 + 0ᵈ.5454472 E
+.10
0ᵈ.00
J. D.
2420000
2430000

Fig. 62.

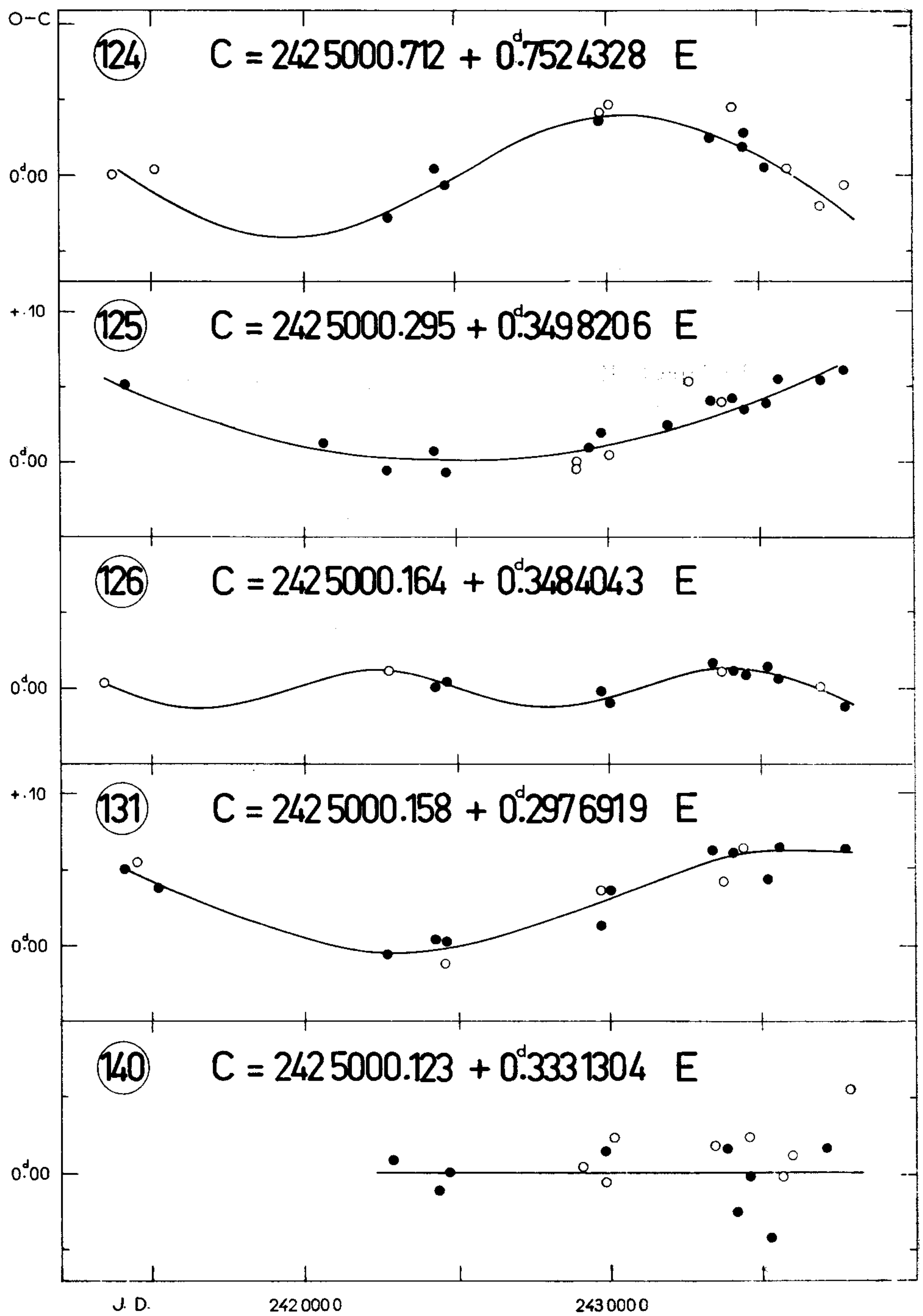

O−C
124
C = 2425000.712 + 0ᵈ.7524328 E
0ᵈ00
+.10
125
C = 2425000.295 + 0ᵈ.3498206 E
0ᵈ00
126
C = 2425000.164 + 0ᵈ.3484043 E
0ᵈ00
+.10
131
C = 2425000.158 + 0ᵈ.2976919 E
0ᵈ00
140
C = 2425000.123 + 0ᵈ.3331304 E
0ᵈ00
J. D.
2420000
2430000

Fig. 63.

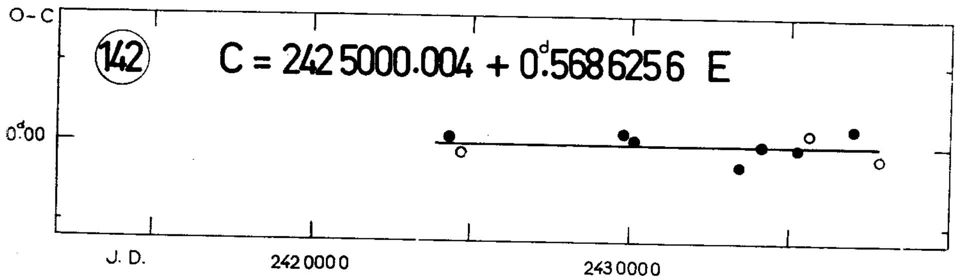


Fig. 64.

Budapest, Konkoly Observatory, 1964 August

REFERENCES

van Agt, S. L. Th. and Oosterhoff, P. Th. 1959 Leiden Ann *21* Part 4.
Arp, H. C. 1955 A. J. *60*. 317
Bailey, S. I. 1913, H. A. *78*. 1
Baker, R. H. and Baker, H. V. 1956, A. J. *61*. 283
Balázs, J. 1959, Kl. Ver. Bamberg *27*. 26
Balázs, J. and Detre, L. several numbers of Budapest Mitt.
Belserene, E. P. 1952, A. J. *57*. 237
1954, A. J. *59*. 406
1964, A. J. *69*. 475
Bronkalla, W. 1960, A. N. *285*. 181
Detre, L. 1955, Trudy tshetvertogo soveshanija po voprosam kosmogonii. Isd. A. N. SSSR Moscow 389 (in Russian)
1962, I. A. U. Trans. vol. XI. B. 293
Fritze, K. 1962, A. N. *287*. 79
Greenstein, J. L. 1935, A. N. *257*. 301
Grubissich, C. 1956, Mem. Soc. Astron. Ital. *27*. 391
Hett, J. H. 1942, A. J. *50*. 77
Izsák, I. G. 1957 Budapest Mitt. *42*. 63
Kinman, T. D. 1961, Royal Observatory Bulletins No 37
Kukarkin, B. V. 1961, Per. Zv. 3. *13*. 384
Kukarkina, N. P. and Kukarkin, B. V. 1961a, Per. Zv. *13*. 239
1961b, Per. Zv. *13*. 309
Larink, J. 1922, Berg. Abh. *2*. Nr. 6
Mannino, G. 1956, Mem. Soc. Astron. Ital. *27*. 169, 263
Martin, W. Chr. 1938, Leiden Ann. *17*, Part 2
1942, Ap. J. *95*. 314
Müller, Th. 1933, Berl. Babels. Veröff. *11*. 1
Notni, P. and Oleak, H. 1958, A. N. *284*. 49
Oosterhoff, P. Th. 1941, Leiden Ann. *17*. Part 4
Ozsváth, I. 1957, Budapest Mitt. *42*. 81
Preston, G. W. 1959, Ap. J. *130*. 507
1964, Ann. Rev. of Astr. and Astroph. Vol. II pp 23—48
Roberts, M. and Sandage, A. R. 1955, A. J. *60*. 185
Rosino, L. 1950, Ap. J. *112*. 221
Sandage, A. R. 1953, A. J. *58*. 61
1959, Ap. J. *129*. 596
Sandage, A. R. and Katem, B. 1964, Ap. J. *139*. 1088j
Sawyer, H. B. 1955, Publ. DDO *2*. No 2
Schwarzschild, M. 1940, H. C. 437
Slavenas, P. 1929, A. N. *240*. 169
Sterne, Th. E. 1934, H. C. 386
Wachmann, A. A. 1965, Astron. Abh. S. 121
Woolf, N. J. 1964, Ap. J. *139*. 1082

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MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
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E. ILLÉS—ALMÁR AND I. ALMÁR

PERIOD CHANGES OF THE SATELLITE 1960 EPSILON 3 IN 1963/64 AS DEDUCED FROM OBSERVATIONS WITHIN THE INTEROBS PROGRAM

BUDAPEST, 1965

PERIOD CHANGES OF THE SATELLITE 1960ε3 IN 1963/64 AS DEDUCED FROM OBSERVATIONS WITHIN THE INTEROBS PROGRAM*

by

E. ILLÉS-ALMÁR and I. ALMÁR

Zusammenfassung. Aus [7] wurden die Beobachtungen des Satelliten 1960 ε3 (Kabine Sputnik 4) ausgewählt und die besten 39 Durchgänge, die sich zwischen 21 August 1963 und 27 Sept. 1964 verteilen, bearbeitet. Zuerst berechnete eine elektronische Rechenmaschine nach der Methode [9] die zu 393 simultanen Vermessungen gehörigen *XYZR* Raumkoordinaten des Satelliten. Dann wurde (nach einem Vorschlag von I. D. Shongolowitsch) bei jedem Durchgang die Durchgangszeit des Satelliten über einen ausgewählten geographischen Breitenkreis bestimmt (Tab. 3). Insofern die Periode sich gleichmässig änderte, konnte die Beschleunigung pro Umlauf $\frac{dP}{dn}$ mittels der Abweichungen zwischen den beobachteten und den mit einer konstanten Periode berechneten Durchgangszeiten bestimmt werden. Es wurden für 31 Durchgänge (267 Raumpunkte enthaltend) Periodenänderungen $\frac{dP}{dn}$ berechnet (Tab. 4). In allen beobachteten Zeitabständen war die Periodenänderung konstant, mit Ausnahme der ersten, wo am 26 August 1963 der $\left|\frac{dP}{dn}\right|$ Wert — parallel mit einer Verminderung der Sonnenfleckenzahl und der Gesamtfläche der Sonnenflecken — plötzlich abgenommen hat (Tab. 5, Abb. 2—8). Diese Änderung war sechsmal grösser als der Standardfehler der vorherigen $\frac{dP}{dn}$ Werte und entsprach einer Verminderung der Luftdichte in der Perigeumhöhe (255 km) um 31%. Es ist bemerkenswert, dass die $\left|\frac{dP}{dn}\right|$ Werte in Juli und Sept. wesentlich kleiner waren als die früheren. Diese Verminderung konnte auch unabhängig davon durch den zeitlichen Verlauf der Umlaufszeit bewiesen werden. Dieser Umstand hängt wahrscheinlich auch mit der Abnahme der Sonnenaktivität zusammen und daraus folgt der prolongierte Untergang des Satelliten.

INTRODUCTION

Air drag is playing a vital role among perturbing forces acting upon the motion of artificial satellites. Its effect becomes visible in the decrease of a, e and the period of revolution (P), these changes being connected with air density in the region near perigee. The decrease of the nodal period of revolution, easily measurable by observing the satellite's reappearance above a given geographic latitude, yealds a suitable tool for the investigation of the influence of air drag on satellite motion. As the deviations between observed and calculated transit times (O—C), on the one hand, and the rate of period

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change, on the other hand, are closely connected, even a regular tracking network of comparatively small extent might produce valuable data for atmospheric physics. Experience shows, however, that the density of upper atmosphere depends on the intensity of solar activity, hence satellite orbit studies may lead to a better understanding of geophysical influences of the Sun in general.

Several successful attempts have been made to utilize optical observations — including also rough visual fixes available in large quantities — in order to investigate changes in the orbital elements of artificial satellites [1]. As optical observations in the general case give only the direction of the satellite with respect to the tracking station, the determination of orbital elements is usually carried out by means of classical celestial mechanics based on a set of observations and on the method of successive approximation (Laplace, Gauss). From an adequate number of optical fixes orbital elements can be obtained, referring to the whole time interval during which the observational material has been collected. The method is more effective if the material is of higher accuracy, more extensive, and covers a longer portion of the whole orbit [2]. In practice, however, because of the quick changes in the elements of artificial satellites due to deviations of the Earth's gravitational field from a central field and also due to air drag, some assumptions must be introduced concerning the direction and speed of changes in the orbital elements in the period under investigation.

If perfect synchronism of observations carried out from a base line of appropriate length on the same satellite can be guaranteed in some way or another, the instantaneous position in space of the satellite is fixed. In this case orbit studies which are based on a limited number of observations are possible. This possibility means, in a fortunate case, a shorter time interval during which the shift of orbital elements may be either easily taken into account or neglected. This fact, important mainly for low-orbit satellites, gives an opportunity of studying even quick changes of certain orbital elements (e.g. period of revolution).

The synchronism of optical fixes may be assured, in general, by several methods:

a). If short light signals are emitted by a satellite at definite times (e.g. ANNA—1B), the position of the satellite with respect to the stars can be photographed from stations at both ends of a base line. This is the best solution of the problem, but owing to technical difficulties it cannot be used frequently.

b) If the camera control systems are connected so that they are activated by the same time signal, then every satellite illuminated by the sun can be photographed simultaneously from the tracking stations. The drawback of the method is that this perfect synchronism encounters serious technical difficulties.

c) If the apparent path of the satellite is supposed to be a great circle, pairs of simultaneous observations may be selected quite independently of time statements [3]. The topocentric radius vector M_2S belonging to a given topocentric radius vector M_1S must lie, however, in the plane defined by the known radius vector M_1S and the base line M_1M_2, and also in the plane described by the apparent path of the satellite (notations see on Fig. 1). The line of intersection of these planes fixes the direction of the satellite from

M_2 at a specified moment. One drawback of this method is that it requires extensive calculations.

d) An interpolation can be used to select a pair of simultaneous observations, frequent and consecutive from at least one of the stations and sporadic from the other, occurring within the same time interval. It is well known that the apparent orbit of an artificial satellite is quite smooth within an interval of less than a minute. Therefore this method has the advantage of reducing the random errors in the observations, since the interpolated values represent mean values of a set of observed azimuthal or equatorial coordinates, provided the orbit is smooth. The method was used in both the Soviet and American triangulation programs [4], [5]; it has been introduced by M. Ill to visual observations [6].

In order to increase the number of simultaneous observations a special network of Hungarian, German, later Soviet, Bulgarian, Polish and Roumanian tracking stations was established in 1961/62 under the designation INTEROBS. It has been organized, according to its coordinator Mr. M. Ill, for the purpose of performing serial observations within previously fixed time intervals on certain artificial satellites. All observations obtained during these intervals („campaigns") were summarized and published at Baja (Hungary) [7]. Several methods have been suggested [8] to evaluate simultaneous observations selected from this material by means of graphic interpolation. The aim of the present paper is to investigate tracking data on the cabin of Sputnik 4 (1960 ε3) using a combination of methods proposed at the conference of satellite observers at Riga in 1965.

Our experiences have shown that the observational material of the first INTEROBS cycles, collected mainly in Eastern Europe, did not enclose a portion of the orbit long enough to allow exact determination of all orbital elements (e and ω in particular) separately for every revolution. Hence, following a proposal of I. D. Zhongolovich, we intended only to study the changes of the nodal period of revolution of the satellite.

From the material available simultaneous observations carried out in the following intervals have been selected: 21—30 Aug. 1963, 17 Feb., 10—13 Apr., 8—13 June, 7—12 July and 18—27 Sept. 1964.

Evaluation has been limited to the following transits:

TABLE 1

Date	No. of transit in [7]	Number of sim. pairs of observations
1963		
21 Aug.	2	6
22	4	15
23	5	9
23	6	18
24	7	1
24	8	8
25	9	2
26	12	9
27	13	8
27	14	4

TABLE 1 (cont.)

Date	No. of transit in [7]	Number of sim. pairs of observations
29	16	12
29	17	5
30	19	5
1964		
17 Feb.	27	14
10 Apr.	38	1
10	40	1
11	42	22
12	46	32
13	49	5
8 June	71	4
9	77	3
11	83	1
12	85	17
13	89	3
13	92	1
7 July	93	28
8	94	21
9	95	27
10	96	6
12	98	18
18 Sept.	118	10
20	119	12
22	120	9
22	122	16
23	123	7
24	127	2
25	128	5
26	134	8
27	138	18

Total: 39 transits 393 simultaneous points

The contribution of tracking stations to the observational material is the following:

TABLE 2

	Country	Station number	Number of fixes
Ryazan	U.S.S.R.	1042	136
Baja	Hungary	1113	124
Budapest	Hungary	1111	84
Vologda	U.S.S.R.	1014	84
Arkhangelsk	U.S.S.R.	1004	80
Cluj	Roumania	1132	47
Chernovtsy	U.S.S.R.	1062	45
Riga	U.S.S.R.	1040	36
Kiev	U.S.S.R.	1023	29
Kishinev	U.S.S.R.	1024	27
Bautzen	G.D.R.	1120	21

TABLE 2 (cont.)

	Country	Station number	Number of fixes
Tartu	U.S.S.R.	1051	17
Olsztyn	Poland	1151	17
Rostov	U.S.S.R.	1041	14
Rodewisch	G.D.R.	1185	8
Erevan	U.S.S.R.	1018	7
Dnepropetrovsk	U.S.S.R.	1017	5
Stara Zagora	Bulgaria	1102	5
Birsk	U.S.S.R.	1085	4
Kazan	U.S.S.R.	1020	1
Petrozavodsk	U.S.S.R.	1038	1
Zvenigorod	U.S.S.R.	1072	1

Total: 22 stations 793 fixes.

Plotting the celestial coordinates against time, pairs of simultaneous observations have been selected by the aforementioned method of graphic interpolation. If serial fixes were made from several stations at the same time, we tried to adopt the procedure of interpolation on the sequences of each station. Single observations are weighted by *1*; coordinates interpolated at the beginning or at the end of a sequence (uncertain values) by *2*; reliably interpolated values by *3*.

The authors would like to thank Mr M. Ill and Mr K. Sütő for kindly permitting the use of pairs of simultaneous points selected by them from the material of the Aug. 1963, Feb. and Apr. 1964 intervals.

THE METHOD

Instantaneous positions in space of the satellite have been determined from pairs of simultaneous fixes according to the procedure proposed at the Riga conference [9]. Its program used in the computer reduction (electronic computer Type Elliott 803) is given in the Appendix.

Starting from observations in the equatorial coordinates ($\alpha_1\delta_1$ and $\alpha_2\delta_2$ respectively) equations are written for planes in a rectangular system fixed in space, satisfying the following two conditions: a) they each contain one observing station, M_1 or M_2; b) they contain angles α_1 and α_2 with the $[XY]$ plane of the coordinate system respectively.

The coordinates x_s and y_s of the satellite are given by the line of intersection of the planes (μ). If straight lines are drawn inside these planes containing the angles $90° - \delta_1$, $90° - \delta_2$ (measured from the North Pole) from stations M_1 and M_2 respectively, their intersection with μ provides two fictitious positions of the satellite in space (S_I, S_{II}) (see Fig. 1). Forming their appropriately weighted mean value, points in space can be obtained which

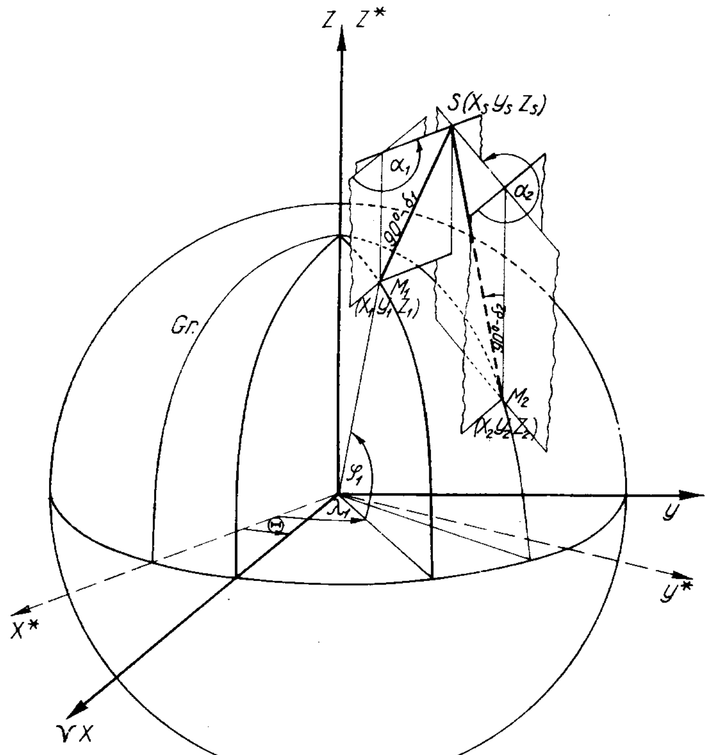


Fig. 1.

serve as a basis for further calculations (S_1, S_2, . . .). The set of equations used is a simple consequence of the basic equation of cosmic triangulation [10]:

$$x_s = \frac{y_2 - y_1 - x_2 \operatorname{tg} \alpha_2 + x_1 \operatorname{tg} \alpha_1}{\operatorname{tg} \alpha_1 - \operatorname{tg} \alpha_2}$$

$$y_s = y_1 + (x_s - x_1) \operatorname{tg} \alpha_1$$

$$z_s = z_1 (x_s - x_1) \operatorname{tg} \delta_1 \sec \alpha_1 = z_2 + (x_s - x_2) \operatorname{tg} \delta_2 \sec \alpha_2$$

It is to be noted that the method offers the advantage of providing a pair of solutions even in the case of not absolutely accurate observations (without a least-squares solution), as the errors in the initial data present themselves in the deviation of the two different results for the z_s coordinate of the satellite. The use of serial fixes makes a graphic smoothing of the x_s, y_s, z_s and $R_s = \sqrt{x_s^2 + y_s^2 + z_s^2}$ values feasible.

I. D. Zhongolovich proposed in a paper presented at the Riga conference under the title "Remarks to the Interobs program" that changes of the nodal period of revolution of satellites should be determined from the visual observations. He proved that sequences of spatial positions give transit times above a given geographic latitude circle (φ_0) accurate to at least a few tenths of a second. Consequently from two passes observed on two consecutive nights the mean period of revolution of the satellite is determinable to a few hundredths of a second. There is hereby a hopeful possibility to analyse quick period changes of low-orbit satellites with an adequate accuracy.

First of all the geocentric latitude of the subsatellite points (φ_n) is needed. It can be easily derived from space coordinates, namely through

$$\sin \varphi_n = \frac{z_n}{R_n}.$$

Plotting φ_n as a function of the epoch of observation (t_n) we are able to perform on the smoothed curve a graphic determination of the satellite's crossing time over the given latitude circle (t_0). The numerical procedure proposed by Zhongolovich is more accurate and makes extrapolation possible. If the path element in question is short, equation

$$t_0 = t_n - \left(\frac{R_n}{\varkappa}\right)^2 (\mu_n - \mu_0) \qquad \sin \mu_n = \frac{\sin \varphi_n}{\sin i}$$

holds true, where

$$\sin \mu_0 = \frac{\sin \varphi_0}{\sin i} \qquad \varkappa = 190.2 \sqrt[4]{a(1-e^2)}$$

if R_n and a are expressed in kilometers, $(t_n - t_0)$ in seconds and $(\mu_n - \mu_0$ in degrees.

Calculating the transit times t_0 belonging to φ_0 from every pair $(t_n\, \varphi_n)$ separately, their mean value $\bar{t}_0$ is to be formed. As a first step, however, approximate values of i, a and e are needed. Orbital elements published by prediction services might be used as a first approximation. Taking them as a starting point, all t_0 values on a selected long transit of high quality should be calculated. If the t_0 values thus obtained show a monotonous decrease or increase as a function of time, the adopted value of i has to be corrected. To derive its correct value we may proceed as follows: if e.g. $t_{01} < t_0 < t_{02}$ where t_{01} and t_{02} are arbitrary t_0 values at the beginning (t_{n1}) and at the end (t_{n2}) of the given transit respectively, we have

$$(t_n - \bar{t}_0)' = k(t_n - \bar{t}_0) \quad \text{where} \quad k = 1 + \frac{t_{02} - t_{01}}{t_{n2} - t_{n1}}$$

$$(\mu_n - \mu_0)' = \frac{k}{\bar{R}_n^2}(\mu_n - \mu_0)$$

$$\sin i' = \frac{\sin^2 \varphi_0 - 2 \sin \varphi_0 \sin \varphi_n \cos (\mu_n - \mu_0)' + \sin^2 \varphi_n}{\sin (\mu_n - \mu_0)'}.$$

Dashed letters are the corrected quantities. A mean value of i', derived from several pairs of (t_{n1}, t_{n2}) equals the correct inclination of the orbital plane.

Then follows the determination of a using $\bar{t}_0$ values of a pair of well observed transits separated by nearly 24 hours $(\bar{t}_{0A}, \bar{t}_{0B})$. With the approximate value of the orbital period, the revolution number (n) between the two selected transits can be guessed. Hence we get

$$P' = \frac{\bar{t}_{0A} - \bar{t}_{0B}}{n}$$

the nodal period of revolution in a closer approximation. Kepler's third law then yields a (the deviation between nodal and sidereal period of revolution is not significant — see later) and combining it with e we obtain $\varkappa$. The value of e can be easily estimated if there are observations near perigee or apogee (i.e. R_{per} or R_{ap} is known), because then

$$e = \frac{R_{\text{ap}}}{a} - 1 = 1 - \frac{R_{\text{per}}}{a}$$

will hold.

Finally, using the corrected i and $\varkappa$ values, the calculation of t_0 from every point of every transit has to be completed. It is advisable to choose φ_0 inside or at least near to the observed portions of the orbits in question, but experience shows that it is acceptable also if subsatellite points are not farther from the selected latitude circle than 6—8 degrees. The mean value of the t_0 values represents the observed crossing time over the latitude φ_0 during a given transit:

$$\bar{t}_{0n} = O_n$$

For organizational reasons, as a rule, Interobs cycles lasted 7—10 days per month, therefore period changes were investigated within each cycle separately.

Calculations may be carried out as follows. Let us suppose as a first approximation that the period is constant and equals to its approximate value, P', furthermore that the starting epoch

$$C_0 = O_0 \text{ and}$$

$$C_n = C_0 + nP' \text{ where } n = 0, 1, 2 \ldots$$

Plotting the $O - C$ values against time, usually a parabola is obtained, in accordance with the general tendency of decreasing of the period of revolution. Then the P_0 period, belonging to the first of the transits observed, is to be determined, using either graphic or — following a proposal of M. Ill — numerical solution. He supposes that during the given time interval nodal period increases steadily by Δ sec per each revolution, then

$$P_0 = P' + \delta$$

where

$$\delta = \frac{n-1}{k(n-k)}(O-C)_k - \frac{k-1}{n(n-k)}(O-C)_n$$

and the period changes during one revolution by

$$\Delta_n = \frac{2(O-C)_n}{n(n-k)} - \frac{2(O-C)_k}{k(n-k)}$$

where $(O - C)_k$ belongs to the k^{th}, $(O - C)_n$ to the n^{th} orbit and $n \neq 0$ $k \neq 0$ $n > k$. For practical purposes two well observed transits should be selected.

Repeating the calculation of residuals using the P_0 value from either the graphic or the numerical solution we have

$$C_0 = O_0 \qquad C_n = C_0 + nP_0$$

which yields as a result the rate of change of the nodal period for each transit separately

$$\Delta_n = \frac{dP}{dn} = \frac{2(O - C)_n}{n(n - 1)} .$$

If these results are equal, i.e. $\Delta_n =$ const., our assumption appears to be valid and the procedure yields the period change in the whole interval in question. If Δ_n varies, we should try to divide the interval into several parts and select points near enough to each other to allow the determination of a $\Delta_n =$ const. value. In practice it may seem reasonable to plot first $2(O - C)_n$ as a function of $n(n - 1)$ and test whether the points lie on a single straight line or not. If it can be assumed that $\Delta_n =$ const., it is worth while to carry out the inverse procedure, namely to determine P_z, the period of revolution belonging to the last transit of the interval. Then in the opposite direction

$$C_z = O_z \qquad C_m = C_z - mP_z \quad \text{where } m = 0, 1, 2 \ldots$$

hence Δ_m can be calculated exactly in the same manner as in the previous case.

The influence of the errors of the observed O_n values on Δ_n being inversly proportional to $n(n - 1)$, we formed a weighted mean of the Δ_n and Δ_m pairs for every transit separately

$$\bar{\Delta} = \frac{n(n - 1)\,\Delta_n + m(m - 1)\,\Delta_m}{n(n - 1) + m(m - 1)} .$$

The result has been considered as the rate of decrease of the period (in sec/rev) during the time interval under consideration.

RESULTS

The part of the observational material published in [7], seemingly most suitable to an investigation of the type outlined above, consisted of 39 transits of 1960 $\varepsilon 3$. Altogether 6 transits have been rejected, partly because the path element observed was too far from the latitude circle φ_0 (pass No. 5), partly because it belonged to a time interval where the number of suitable transits to deduce period changes proved to be insufficient (pass No. 27 and passes No. 77, 83, 89, 92 respectively).

One third of all positions in space, given by the computer program, have been similarly neglected (126 points out of 393). These points have been rejected because

a) they belong to transits already cancelled;
b) they were far from the latitude circle φ_0;

c) the length of their radius vector, R, differed considerably from all other R values of the transit (in some cases it is a consequence of the decreased parallax of the satellite as seen from the pair of stations);

d) another set of $XYZR$ values could be derived from other observations but referring to the same moment. In this case corresponding quantities have been averaged.

A review of the whole observational material is given in Table 1.

Positions in space actually used, the partial results of the Zhongolovich method and transit times are summarized in Table 3.

TABLE 3

	t_n h	m	s	z_n km	R_n km	$t_o - t_n$ s	t_o h	m	s
1963									
21.8	20	34	2.8	6020.	6858.83	20.1	20	34	22.9
		34	6.7	6010.5	6848.37	19.9		34	26.6
22.8	21	4	17.9	6110.43	6859.57	81.2	21	5	39.1
		4	31.4	6090.99	6861.64	64.9		5	36.3
		4	36.4	6087.69	6861.62	62.5		5	38.9
		4	40.2	6082.55	6861.98	58.7		5	38.9
		5	3.7	6052.	6863.	37.6		5	41.3
		5	5.3	6048.	6864.	34.5		5	39.8
		5	27.2	6015.09	6862.84	15.3		5	42.5
		6	5.0	5942.	6866.	− 25.1		5	39.9
		6	24.0	5902.50	6867.69	− 44.7		5	39.3
		6	34.2	5878.51	6866.34	− 55.1		5	39.1
		6	44.0	5853.54	6862.84	− 64.7		5	39.3
23.8	20	3	43.9	6094.75	6857.87	70.2	20	4	54.1
		3	51.9	6082.94	6855.64	62.9		4	54.8
		4	3.1	6062.33	6856.60	47.9		4	51.0
		4	5.8	6060.84	6855.22	47.7		4	53.5
		4	30.0	6022.95	6857.82	22.4		4	52.4
		4	43.4	6001.38	6860.18	8.8		4	52.2
		4	58.7	5974.39	6859.39	− 5.6		4	53.1
		5	5.0	5970.77	6874.76	− 10.0		4	55.0
		5	46.5	5874.21	6858.28	− 53.8		4	52.7
		6	5.0	5833.03	6859.42	− 72.2		4	52.8
24.8	19	4	0.2	5741.15	6588.34	3.7	19	4	3.9
	20	34	57.6	6083.11	6851.52	65.6	20	36	3.2
		35	15.1	6058.43	6853.67	47.0		36	2.1
		35	17.8	6054.62	6851.09	46.0		36	3.8
		35	38.5	6024.46	6856.65	23.9		36	2.4
		36	29.0	5932.74	6858.58	− 26.5		36	2.5
25.8	19	34	4.3	6103.25	6865.52	71.6	19	35	15.9
		36	28.6	5831.57	6879.74	− 80.5		35	8.1
26.8	20	5	26.8	6062.73	6859.66	46.4	20	6	13.2
		5	30.4	6058.48	6858.20	44.5		6	14.9
		5	32.7	6055.18	6857.24	42.8		6	15.5
		5	33.3	6054.48	6857.11	42.5		6	15.8
		5	40.4	6044.36	6855.46	36.9		6	17.3
		6	0.4	6012.86	6856.22	17.3		6	17.7
		7	39.0	5808.94	6855.04	− 80.6		6	18.4
27.8	19	5	14.4	6000.01	6855.34	10.4	19	5	24.8
		5	52.1	5938.	6858.99	− 24.1		5	28.0
		6	4.0	5912.84	6874.50	− 42.7		5	21.3

TABLE 3 (cont.)

	t_n h	t_n m	t_n s	z_n km	R_n km	$t_o - t_n$ s	t_o h	t_o m	t_o s
		6	5.0	5910.95	6875.98	— 44.2		5	20.8
		6	39.3	5825.51	6857.24	— 74.5		5	24.8
	20	36	49.8	6092.35	6928.63	27.3	20	37	17.1
		39	3.7	5760.66	6860.36	—101.9		37	21.8
		39	4.6	5754.54	6854.32	—102.1		37	22.5
		39	5.6	5747.28	6844.68	—101.5		37	24.1
29.8	18	34	32.3	6073.52	6855.59	56.2	18	35	28.5
		34	59.1	6032.15	6857.14	28.3		35	27.4
		35	3.8	6029.80	6860.94	24.9		35	28.7
		35	4.6	6031.07	6863.07	24.6		35	29.2
		35	5.5	6032.27	6865.09	24.2		35	29.7
		36	3.8	5905.21	6851.47	— 36.7		35	27.1
		36	4.8	5903.23	6851.77	— 37.8		35	27.0
		36	6.1	5901.27	6852.49	— 39.0		35	27.1
		36	10.5	5900.06	6859.18	— 42.4		35	28.1
	20	7	23.4	5990.36	6862.02	1.8	20	7	25.2
		7	49.8	5939.31	6863.97	— 25.6		7	24.2
		7	52.9	5941.68	6871.21	— 27.6		7	25.3
30.8	19	6	34.6	5968.99	6859.71	— 8.6	19	6	26.0
		6	34.8	5969.20	6859.39	— 8.3		6	25.5
1964									
10.4	18	14	7.5	5107.44	6753.54	10.6	18	14	18.1
	19	46	14.2	5287.86	6780.66	— 32.9	19	45	41.3
11.4	18	34	37.2	4888.92	6822.06	78.5	18	35	55.7
		34	40.8	4902.36	6817.63	74.4		35	55.2
		34	43.3	4910.40	6813.19	71.6		35	54.9
		34	44.9	4916.75	6812.34	69.9		35	54.8
		34	48.1	4927.56	6806.41	66.2		35	54.3
		34	51.0	4940.47	6806.28	63.0		35	54.0
		34	52.5	4944.53	6803.25	61.5		35	54.0
		34	56.3	4963.	6801.32	56.6		35	52.9
		34	59.0	4974.	6795.90	52.8		35	51.8
		34	59.6	4976.64	6805.79	54.1		35	53.7
		35	2.9	4994.18	6810.19	50.7		35	53.6
		35	5.9	5009.50	6813.21	47.6		35	53.5
		35	9.8	5027.16	6814.47	43.3		35	53.1
		35	11.5	5032.33	6812.09	41.5		35	53.0
		35	13.1	5037.87	6810.68	39.9		35	53.0
		35	15.8	5047.97	6809.14	37.0		35	52.8
		35	18.4	5056.	6802.86	33.7		35	52.1
		35	20.8	5059.60	6799.49	32.2		35	53.0
		35	24.9	5072.70	6795.92	28.1		35	53.0
12.4	18	57	18.0	5143.25	6781.82	6.9	18	57	24.9
		57	23.5	5175.94	6790.47	0.0		57	23.5
		57	28.7	5195.29	6790.15	— 5.3		57	23.4
		57	31.7	5201.69	6786.30	— 7.8		57	23.9
		57	33.9	5207.49	6786.19	— 9.4		57	24.5
		57	39.0	5218.91	6779.86	— 13.8		57	25.2
		57	43.5	5223.77	6770.78	— 17.0		57	26.5
		57	46.3	5253.41	6785.25	— 22.2		57	24.1
		57	50.3	5262.78	6780.38	— 25.9		57	24.4
		57	55.3	5288.62	6786.64	— 31.8		57	23.5
		57	59.4	5299.50	6784.09	— 35.5		57	23.9
		58	4.6	5312.73	6780.55	— 40.0		57	24.6

TABLE 3 (cont.)

	t_n h	t_n m	t_n s	z_n km	R_n km	$t_o - t_n$ s	t_o h	t_o m	t_o s
		58	9.4	5325.72	6777.97	— 44.3		57	25.1
		58	14.0	5340.78	6777.23	— 48.9		57	25.1
		58	18.8	5358.97	6778.01	— 54.0		57	24.8
		58	23.4	5376.34	6778.87	— 59.0		57	24.4
		58	26.9	5387.13	6778.15	— 62.4		57	24.5
		58	30.8	5400.01	6777.84	— 66.4		57	24.4
		58	33.8	5408.82	6777.49	— 69.2		57	24.6
		58	38.8	5414.63	6770.89	— 72.4		57	26.4
		58	42.8	5430.92	6772.68	— 77.0		57	25.8
13.4	17	48	47.6	5426.59	6775.45	10.2	17	48	57.8
		48	49.3	5437.17	6775.39	6.9		48	56.2
		48	56.8	5458.46	6776.53	0.5		48	57.3
		50	14.1	5679.95	6774.16	— 76.6		48	57.5
8.6	0	18	36.2	4643.84	6754.14	102.3	0	20	18.5
		18	48.4	4697.44	6752.85	90.1		20	18.5
		19	1.9	4759.26	6751.10	75.8		20	17.7
		19	17.6	4820.83	6747.15	60.8		20	18.4
12.6	0	5	42.0	4933.49	6758.85	36.1	0	6	18.1
		6	16.5	5069.15	6749.97	0.4		6	16.9
		6	19.1	5069.95	6742.04	— 1.3		6	17.8
		6	20.5	5084.84	6750.54	— 3.5		6	17.0
		6	24.6	5100.91	6750.15	— 7.8		6	16.8
		6	31.2	5125.03	6748.76	— 14.4		6	16.8
		6	33.1	5133.45	6749.98	— 16.3		6	16.8
		6	34.6	5125.46	6739.29	— 16.3		6	18.3
		6	37.6	5134.63	6737.21	— 19.2		6	18.4
		6	42.6	5143.52	6729.61	— 23.0		6	19.6
		6	44.7	5175.52	6747.64	— 28.1		6	16.6
		7	13.4	5276.78	6743.11	— 57.1		6	16.3
		7	19.2	5287.78	6736.80	— 61.5		6	17.7
7.7	0	37	59.6	4860.98	6601.83	— 56.2	0	37	3.4
		38	0.2	4854.41	6601.74	— 55.3		37	4.9
		38	3.8	4864.64	6635.36	— 59.4		37	4.4
		38	3.9	4866.70	6640.38	— 59.9		37	4.0
		38	7.3	4852.35	6639.35	— 63.1		37	4.2
		38	10.3	4843.32	6644.37	— 66.2		37	4.1
		38	12.3	4831.54	6639.01	— 68.0		37	4.3
		38	16.6	4814.69	6640.10	— 72.2		37	4.4
		38	18.4	4809.48	6643.77	— 74.1		37	4.3
		38	20.4	4800.52	6642.09	— 75.9		37	4.5
		38	22.9	4791.36	6645.93	— 78.8		37	4.1
		38	24.2	4785.95	6645.32	— 80.0		37	4.2
		38	26.5	4777.49	6648.37	— 82.6		37	3.9
		38	28.6	4768.32	6649.01	— 84.8		37	3.8
		38	33.5	4744.89	6642.83	— 89.0		37	4.5
		38	34.9	4738.86	6644.81	— 90.8		37	4.1
		38	42.1	4706.07	6639.95	— 97.3		37	4.8
		38	44.2	4697.43	6640.31	— 99.3		37	4.9
		38	47.1	4684.79	6639.51	—102.1		37	5.0
		38	47.8	4680.92	6638.97	—102.9		37	4.9
		38	50.5	4668.94	6637.18	—105.2		37	5.3
		38	56.6	4641.99	6638.00	—111.4		37	5.2
		38	59.1	4632.78	6636.94	—113.3		37	5.8
		39	1.3	4621.96	6637.93	—115.8		37	5.5

TABLE 3 (cont.)

	t_n			z_n	R_n	$t_o - t_n$	t_o		
	h	m	s	km	km	s	h	m	s
		39	6.9	4599.51	6636.37	—120.5		37	6.4
8.7	23	42	45.9	5128.98	6652.95	4.4	23	42	50.3
		42	58.8	5067.39	6643.29	— 10.0		42	48.8
		42	58.9	5073.59	6647.58	— 9.3		42	49.6
		42	59.6	5072.33	6649.09	— 9.9		42	49.7
		43	1.3	5055.44	6641.69	— 12.8		42	48.5
		43	1.6	5063.18	6648.40	— 12.1		42	49.5
		43	2.8	5068.83	6656.49	— 12.3		42	50.5
		43	3.3	5056.21	6648.41	— 14.0		42	49.3
		43	3.8	5043.74	6640.33	— 15.6		42	48.2
		43	4.5	5054.12	6650.77	— 15.0		42	49.5
		43	7.3	5019.17	6632.89	— 20.4		42	46.9
		43	12.0	5000.94	6631.83	— 24.9		42	47.1
		43	13.3	5004.66	6638.05	— 25.2		42	48.1
		43	16.8	5003.09	6647.08	— 27.4		42	49.4
		43	19.0	4998.61	6650.34	— 29.2		42	49.8
9.7	22	29	17.5	5277.51	6654.29	45.9	22	30	3.4
		29	30.8	5221.53	6643.98	32.0		30	2.8
		29	31.1	5229.64	6650.71	31.4		30	2.5
		29	32.8	5217.71	6643.07	31.1		30	3.9
		29	33.7	5223.84	6650.89	31.1		30	4.8
		29	35.5	5217.37	6650.22	29.4		30	4.9
		29	47.8	5172.63	6649.83	17.0		30	4.8
		29	48.8	5170.49	6649.04	16.6		30	5.4
		30	1.5	5124.09	6649.02	3.9		30	5.4
		30	1.8	5120.42	6647.84	3.2		30	4.6
		30	2.9	5115.17	6648.13	1.7		30	4.6
		30	3.5	5113.63	6647.84	1.3		30	4.8
		30	4.2	5110.01	6649.05	0.1		30	4.3
		30	4.3	5111.41	6651.43	0.0		30	4.3
		30	5.6	5103.68	6648.23	— 1.4		30	4.2
		30	11.0	5081.84	6644.50	— 6.4		30	4.6
		30	12.0	5072.41	6640.64	— 8.1		30	3.9
		30	17.7	5063.50	6649.84	— 12.4		30	5.3
		30	17.9	5062.39	6648.28	— 12.3		30	5.6
10.7	22	48	3.4	5187.55	6638.88	23.5	22	48	26.9
		48	4.3	5179.83	6634.82	22.1		48	26.4
		48	7.4	5174.19	6636.66	20.2		48	27.6
		48	15.6	5163.91	6653.04	13.9		48	29.5
		48	16.3	5152.48	6647.66	11.9		48	28.2
		48	17.3	5137.48	6641.20	9.2		48	26.5
12.7	21	52	27.8	5427.84	6649.54	93.5	21	54	1.3
		52	28.8	5425.39	6649.57	92.7		54	1.5
		52	29.9	5421.51	6649.09	91.5		54	1.4
		52	30.8	5419.21	6649.34	90.7		54	1.5
		52	32.0	5415.74	6649.30	89.6		54	1.6
		52	32.7	5413.68	6649.39	88.9		54	1.6
		52	33.7	5411.67	6659.71	85.8		53	59.5
		53	14.1	5281.86	6645.06	49.2		54	3.3
		53	19.4	5257.84	6653.90	40.4		53	59.8
		53	19.8	5262.27	6647.48	42.9		54	2.7
		53	31.1	5211.77	6649.45	27.9		53	59.0
		53	32.4	5205.10	6649.63	26.1		53	58.5
		53	33.6	5208.04	6648.43	27.2		54	0.8
18.9	2	5	0.6	4954.33	6644.91	—933.9	1	49	26.7

TABLE 3 (cont.)

	t_n h	m	s	z_n km	R_n km	$t_o - t_n$ s	t_o h	m	s
		5	2.3	4948.46	6643.43	—934.6		49	27.7
		5	29.7	4829.03	6636.74	—960.6		49	29.1
		5	32.2	4813.30	6626.59	—959.6		49	32.6
		5	34.1	4812.87	6640.79	—966.3		49	27.8
		5	45.2	4760.84	6630.23	—973.6		49	31.6
		6	5.7	4675.89	6636.61	—996.0		49	29.7
		6	11.2	4657.66	6636.95	—1000.2		49	31.0
20.9	17	30	6.1	4926.57	6674.28	112.0	17	31	58.1
		30	7.8	4930.97	6671.76	110.4		31	58.2
		30	9.7	4938.37	6671.38	108.4		31	58.1
		30	19.8	4982.93	6673.96	97.8		31	57.6
		30	26.5	4989.78	6658.22	92.7		31	59.2
		30	30.7	5031.35	6678.74	86.6		31	57.3
		30	49.3	5095.04	6671.35	68.4		31	57.7
		30	50.3	5096.26	6669.22	67.6		31	57.9
22.9	16	34	2.6	5477.57	6656.56	— 48.7	16	33	13.9
		34	3.8	5479.62	6655.14	— 49.9		33	13.9
		34	4.8	5482.16	6654.74	— 50.8		33	14.0
		34	5.8	5485.12	6654.91	— 51.8		33	14.0
		34	6.9	5487.38	6653.99	— 52.5		33	14.4
		34	7.9	5491.00	6654.71	— 53.8		33	14.1
		34	35.6	5568.86	6655.83	— 81.3		33	14.3
		34	36.8	5573.55	6657.15	— 82.6		33	14.2
		34	38.0	5578.89	6658.95	— 84.1		33	13.9
	18	3	29.6	5178.92	6668.67	45.1	18	4	14.7
		4	2.9	5297.01	6667.70	11.1		4	14.0
		4	30.5	5391.38	6668.67	— 17.5		4	13.0
		4	48.8	5442.07	6664.26	— 34.9		4	13.9
		4	52.0	5447.39	6664.68	— 36.5		4	15.5
		4	59.5	5471.38	6662.69	— 45.0		4	14.5
		5	4.6	5493.56	6666.04	— 51.7		4	12.9
		5	30.4	5542.81	6649.05	— 73.7		4	16.7
23.9	18	21	34.1	5521.20	6642.81	— 67.6	18	20	26.5
		22	3.2	5574.84	6631.69	— 90.5		20	32.7
		22	29.5	5618.38	6620.82	—110.8		20	38.7
		22	31.3	5700.50	6661.52	—132.1		20	19.2
		22	32.5	5700.74	6660.27	—132.6		20	19.9
		23	1.0	5823.06	6695.36	—177.3		20	3.7
24.9	18	38	2.4	5608.90	6655.49	— 96.5	18	36	25.9
		38	34.2	5677.66	6649.56	—126.2		36	28.0
25.9	17	23	1.7	5609.73	6656.91	— 96.4	17	21	25.3
		23	3.1	5612.12	6655.79	— 97.7		21	25.4
		23	17.9	5644.91	6650.97	—112.2		21	25.7
		23	18.6	5644.74	6648.72	—112.8		21	25.8
		23	19.0	5644.56	6647.10	—113.2		21	25.8
26.9	17	39	0.2	5618.85	6667.50	— 96.8	17	37	23.4
		40	2.3	5742.56	6651.61	—154.4		37	27.9
		40	2.7	5742.10	6651.25	—154.3		37	28.4
		40	3.1	5743.18	6651.82	—154.6		37	28.5
		40	3.6	5746.71	6653.99	—155.5		37	28.1
27.9	16	25	3.7	5764.70	6657.87	—162.6	16	22	21.1
		25	4.7	5765.68	6656.70	—163.5		22	21.2
		25	5.7	5766.35	6655.23	—164.4		22	21.3
		25	6.5	5767.83	6654.72	—165.3		22	21.2
		25	32.9	5805.78	6647.18	—187.6		22	25.3

TABLE 3 (cont.)

t_n h	m	s	z_n km	R_n km	$t_o - t_n$ s	t_v h	m	s
	25	33.2	5796.57	6640.98	—185.2		22	28.0
	25	33.9	5796.86	6640.72	—185.5		22	28.4
	25	35.0	5800.53	6642.86	—186.5		22	28.5
	25	35.8	5798.89	6641.80	—186.1		22	29.7
	25	36.9	5805.03	6645.17	—188.0		22	28.9
	26	4.2	5858.08	6647.43	—217.2		22	27.0
	26	5.1	5859.95	6648.00	—218.1		22	27.0
	26	6.0	5860.88	6647.78	—218.8		22	27.2
	26	6.9	5861.11	6646.86	—219.4		22	27.5

Different kinds of Δ values deduced from 31 passes by graphic or numerical solution are given in Table 4. In the first column "O" means simply the mean of the t_0 values of Table 3, averaged for each revolution separately. In the second column the root-mean-square error of $\bar{t}_0$ (expressed in seconds) is given for all transits which include a large enough number of observations. Its average value is 0.656.

Note: The epoch $O = 496.259943$ comes from two O values combined from two consecutive transits, each containing one pair of simultaneous observations only.

The next table gives the period at the beginning and at the end of each observation cycle, its mean value, the mean rate of decrease of the period during each time interval, and its standard error. (As $\frac{dP}{dn}$ changed suddenly on 26 August 1963, the first cycle has been divided into two parts.) Then follows, as a comparison, $\left(\frac{dP}{dn}\right)^*$, defined as the slope of a plot of $\bar{P}$ against t at the cycles of observation. Finally theoratical values of $\frac{dP}{dn}$ are given $\left(\left(\frac{dP}{dn}\right)_{t1} \text{ and } \left(\frac{dP}{dn}\right)_{t2}\right)$ calculated from the following equations

$$\left(\frac{dP}{dn}\right)_{t1} = -\frac{3}{4}\frac{e_0}{t_L}\frac{T_0}{(1-t/t_L)^{1/2}}$$

$$\left(\frac{dP}{dn}\right)_{t2} = -\frac{9}{10}\frac{e_0}{t_L}\frac{T_0}{(1-t/t)^{1/2}}$$

[11] where $T_0 = 94.27$ min., $e_0 = 0.030$ are initial orbital elements of the satel-

TABLE 4

O JD 2438... day	σ sec	Weight	$(O-C)_n$ day	$n(n-1)$	Δ_n sec/rev	$(O-C)_m$ day	$m(m-1)$	Δ_m sec/rev	$\bar{\Delta}$ sec/rev
263.357229	± —	1	—	0	—	—.000292	4556	—.0111	—.0111
264.378929	.467	10	—.000012	240	—.0086	—.000161	2652	—.0105	—.0103
265.336725	.389	8	—.000071	930	—.0132	—.000086	1332	—.0112	—.0120
266.294488	—	0.5	—.000162	2070	—.0135	—.000044	462	—.0165	—.0140
266.358366	.309	5	—.000141	2162	—.0113	—.000014	420	—.0058	—.0104
267.316111	—	1	—.000251	3782	—.0115	+.000009	30	+.0518	—.0115
268.337686	.683	7	—.000004	110	—.0063	—.000177	3782	—.0081	—.0080
269.295416	1.320	5	—.000024	650	—.0064	—.000092	2256	—.0070	—.0069
269.359276	—	4	—.000014	702	—.0035	—.000075	2162	—.0060	—.0054
271.274631	.333	8	—.000159	3192	—.0086	—.000010	272	—.0063	—.0084
271.338481	—	3	—.000159	3306	—.0083	—.000003	240	—.0021	—.0079
272.296129	—	1	—.000261	5256	—.0086	—	0	—	—.0086
496.259943	—	1	—	0	—	—.000168	2162	—.0134	—.0134
497.274926	.237	8	—.000019	240	—.0137	—.000069	930	—.0128	—.0130
498.289868	.186	8	—.000079	992	—.0138	—.000012	210	—.0099	—.0131
499.241334	—	3	—.000178	2162	—.0142	—	0	—	—.0142
583.525747	.136	10	—	0	—	—.000275	8556	—.0056	—.0056
585.488068	.276	8	—.000027	930	—.0050	—.000117	3782	—.0053	—.0053
586.437551	.194	9	—.000067	2070	—.0056	—.000068	2162	—.0054	—.0055
587.450319	.486	4	—.000123	3782	—.0056	—.000029	930	—.0054	—.0056
589.412511	.389	8	—.000279	8556	—.0056	—	0	—	—.0056
656.576036	.582	3	—	0	—	—.000781	22952	—.0059	—.0059
659.230532	.200	8	—.000068	1722	—.0068	—.000416	11990	—.0060	—.0061
661.189746	.197	9	—.000175	5256	—.0058	—.000203	6162	—.0057	—.0057
661.252945	.448	5	—.000180	5402	—.0058	—.000198	6006	—.0057	—.0057
662.264160	4.994	0.5	—.000227	8010	—.0049	—.000080	3782	—.0037	—.0045
663.275312	—	1	—.000338	11130	—.0053	—.000026	2070	—.0022	—.0048
664.223213	.105	5	—.000496	14520	—.0059	—.000029	930	—.0054	—.0059
665.234344	.971	4	—.000627	18632	—.0058	—.000005	210	—.0041	—.0058
666.182243	.865	3	—.000787	22952	—.0059	—	0	—	—.0059

TABLE 5

Date	Po day	Pz day	$\bar{P}$ day	$\frac{dP}{dn}$ sec	σ	$\left(\frac{dP}{dn}\right)^*$ sec	$\left(\frac{dP}{dn}\right)_{t1}$ sec	$\left(\frac{dP}{dn}\right)_{t2}$ sec
Aug 1963 I.	.0638570	.0638443	.0638506	—.0110	±.0006	—.0101	—.0072	—.0084
Aug 1963 II.	.0638570	.0638443	.0638506	—.00755	.00049	—.0101	—.0072	—.0084
Apr 1964	.0634376	.0634303	.0634340	—.0132	.0003	—.0092	—.0089	—.0103
Jun 1964	—	—	.0633376	—	—	—	—	—
Jul 1964	.0633015	.0632956	.0632986	—.00550	.00006	—.0075	—.0098	—.0113
Sep 1964	.0632039	.0631936	.0631987	—.00582	.00020	—.0068	—.0109	—.0126

TABLE 6

Date	i	e	$\varkappa$	φ_o	μ_o	U_s min	a km	h_{ap} km	h_{per} km
Aug 1963	64.94	.0173	1723.73	60.750	74.394	92.001	6750.80	490	256
Apr 1964	64.98	.0152	1721.87	49.662	57.264	91.401	6721.45	445	241
June 1964	64.98	.011	1721.34	—	—	91.264	6714.70	411	263
July 1964	64.98	.011	1721.32	50.217	58.000	91.208	6711.96	408	260
Sept 1964	64.97	.0104	1720.85	53.131	61.996	91.064	6704.89	397	256

lite, and t_L its total lifetime. Orbital elements in the predictions for March 1965, using the inverse form of the equations quoted above, yielded lifetimes 1874 days and 1896 days respectively. (The actual lifetime of the satellite proved to be somewhat longer.)

Figures No 2—8 have been plotted to illustrate the graphic solution of the problem. On Fig. No 2, 4, 5 and 7 deviations between observed and

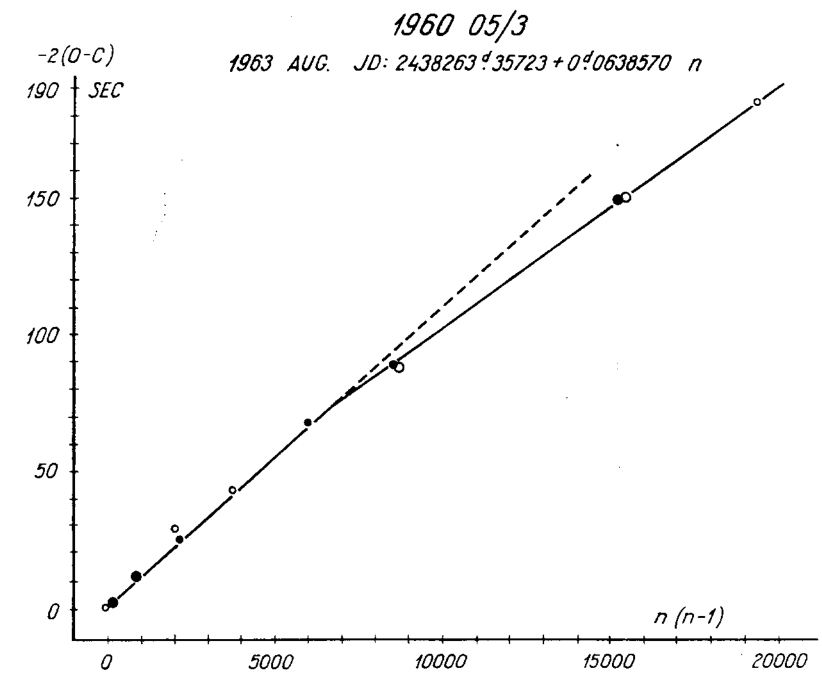
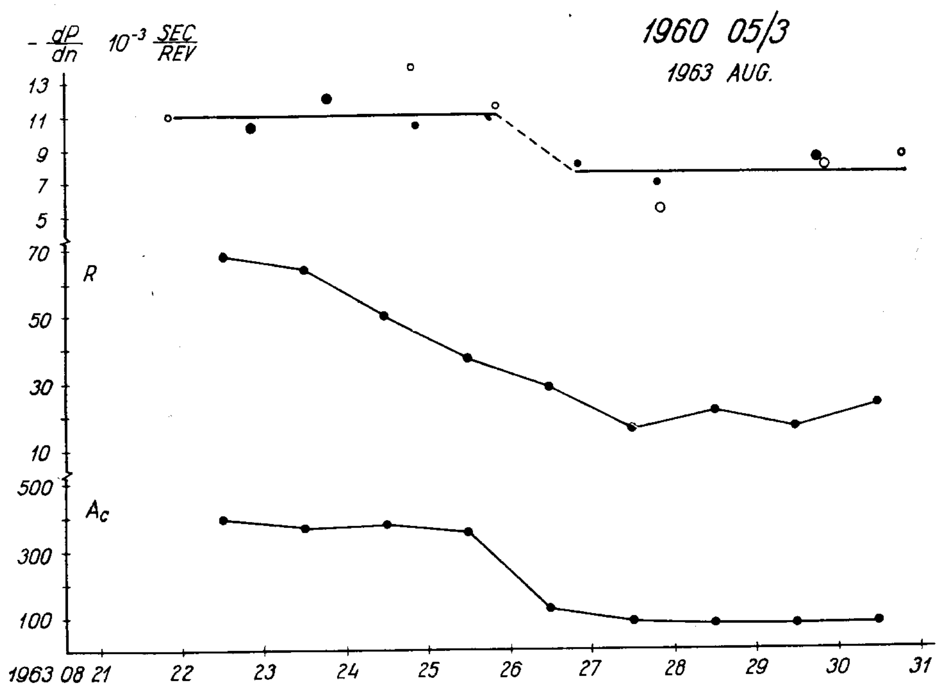


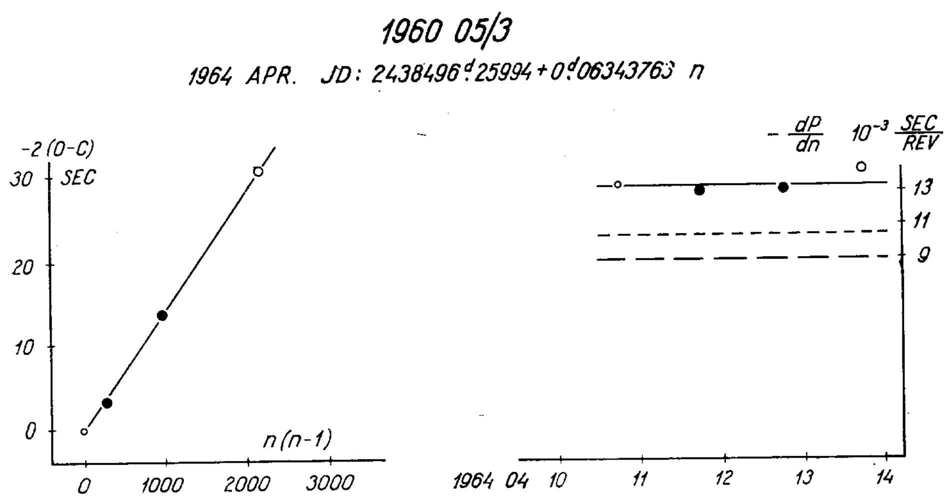
Fig. 2.

calculated transit times $(O - C)_n$ are plotted against $n(n - 1)$; the slope of each straight line gives Δ_n. C_n values have been derived using the initial period of revolution P_0 and the starting date O_0. Fig. 2 proves clearly the reality of the sudden change which occurred on or about the 26[th] August. Dashed lines indicate $\left(\frac{dP}{dn}\right)_{t1}$ and $\left(\frac{dP}{dn}\right)_{t2}$ respectively. (There is certainly a wide gap between the observed and the theoratical values.) Weights of singular points are marked on each of the figures by ●● ○○ (in decreasing order). Parameters of major importance for the computations are summarized in the first columns of Table 6 ($i, e\,\varkappa$ and $\varphi_0\,\mu_0$, latters representing the reference latitude). Approximate orbital elements have been found in [12] and have been corrected according to the method mentioned above.



1960 05/3
1963 AUG.
$-\frac{dP}{dn}$ 10^{-3} $\frac{SEC}{REV}$
13
11
9
7
5
70
R
50
30
10
500
A_c
300
100
1963 08 21
22
23
24
25
26
27
28
29
30
31

Fig. 3.



1960 05/3
1964 APR. JD: 2438496ᵈ.25994 + 0ᵈ.06343763 n
-2 (O-C)
SEC
30
20
10
0
n (n-1)
0
1000
2000
3000
$-\frac{dP}{dn}$ 10^{-3} $\frac{SEC}{REV}$
13
11
9
1964 04 10
11
12
13
14

Fig. 4.

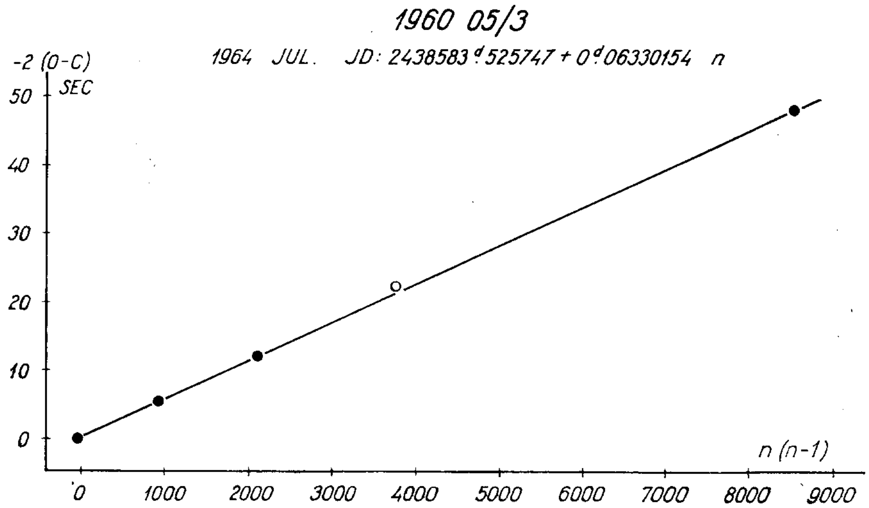

1960 05/3
1964 JUL. JD: 2438583^d525747 + 0^d06330154 n
-2 (O-C) SEC
50
40
30
20
10
0
n (n-1)
0 1000 2000 3000 4000 5000 6000 7000 8000 9000

Fig. 5.

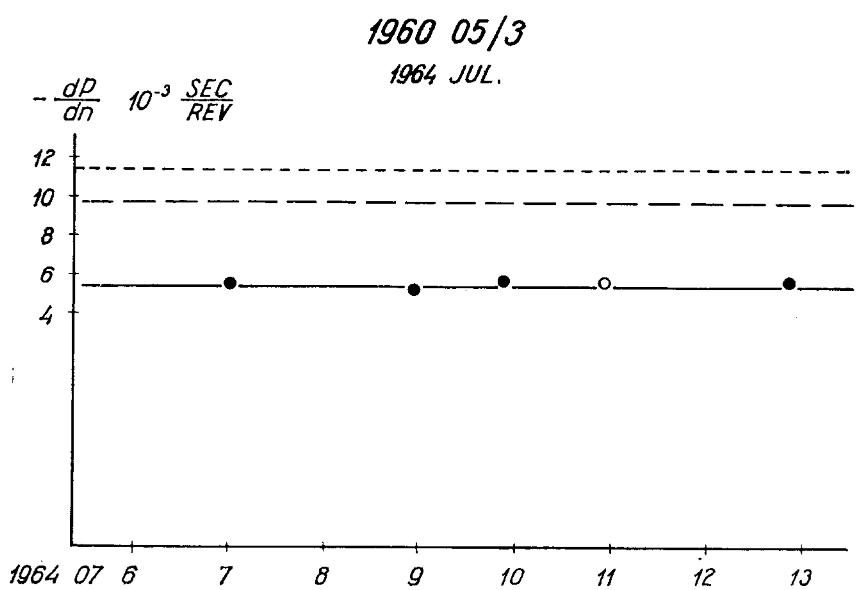

1960 05/3
1964 JUL.
- dP/dn 10^-3 SEC/REV
12
10
8
6
4
1964 07 6 7 8 9 10 11 12 13

Fig. 6.

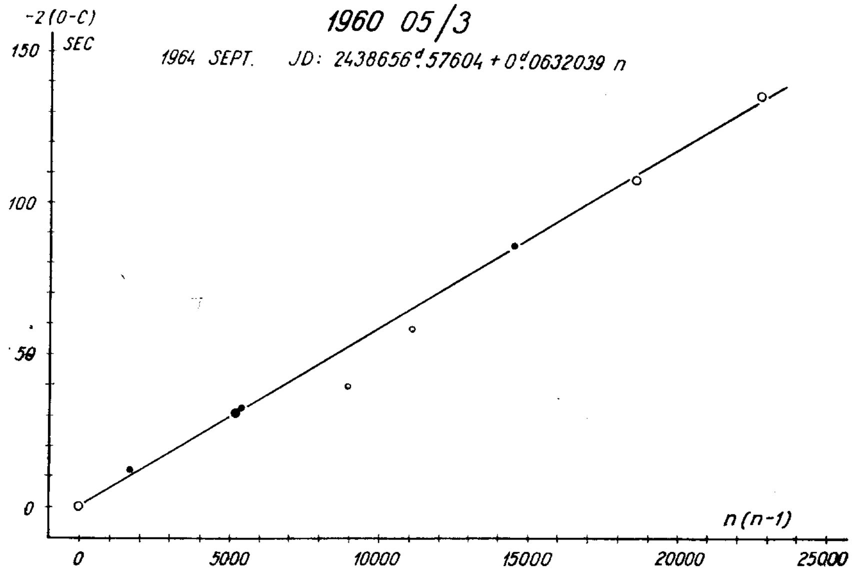
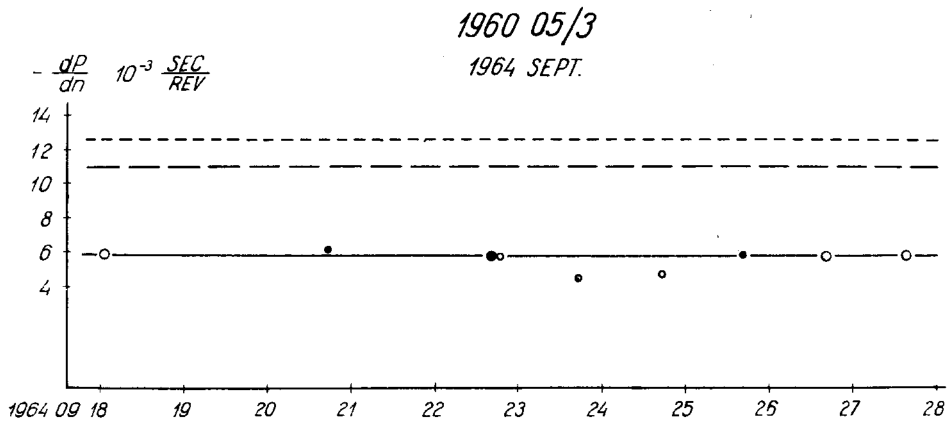


Fig. 7.



Fig, 8.

The last four columns give U_s (derived from $\bar{P}$), a, and the values of h_{ap} and h_{per} — being simple functions of a and e. The sidereal period of revolution can be computed from

$$U_s = P\left(1 + \frac{p}{v}\right)$$

[6], where

$$p = 9.97\left(\frac{R}{a}\right)^{3.5} \frac{\cos i}{\sqrt{1 - e^2}} \approx 3.5°/\text{day}$$

is the daily precession of the orbital plane,

$$v = \frac{|\mu_{n2} - \mu_{n1}|}{t_{n2} - t_{n1}} \approx 3.9°/\text{min}$$

is the average angular velocity easily measurable on the observed path elements. The sidereal period proved to be longer than the nodal one by 3—4 sec.

Consequently satellite accelerations as derived refer practically to a perigee altitude of 255 km.

CONCLUSIONS

The Interobs program sets as an aim the investigation of sudden changes in the upper atmosphere as revealed by satellite drag. Studying the observational data on 1960 ε3 (1960 05/3) we demonstrated the possibility of regarding $\frac{dP}{dn}$ as constant for time intervals of 8—10 days (at least during and about the minimum of solar activity) and to derive its mean value with no more than 20% external relative error. Consequently the density of the atmosphere near the perigee altitude of the satellite proved to be constant during most of the time intervals under consideration. Nevertheless we did not intend to determine it numerically for the following reasons: we did not succeed to derive the argument of perigee (the observations covering only a small fraction of the whole orbit) and also the effective cross-sectional area of the satellite is unknown. As the possibility of a slow precessional motion of the axis of rotation of the satellite (with a period of rotation of the order of weeks!) cannot be precluded [13], absolute measurements of air density are hampered by the corresponding variations of the cross-sectional area of the satellite at least if only one satellite is under observation.

Sudden variations, like the one shown on Fig. 2 and 3, however, cannot be regarded as anything else but as the consequences of sudden changes in the density of the upper atmosphere. Hence according to the changes of drag acting on 1960 ε3, air density near its perigee altitude decreased by 31% on the 26th August 1963. The change exceeds six times the standard error of $\frac{dP}{dn}$ for the preceding time interval.

It is natural to try to find a connection between this density decrease and variations in the actual solar activity, because a strong correlation between certain solar phenomena and the upper atmosphere is well known [14]. Exactly on the day mentioned a larger sunspot group turned away to the farside of the Sun, and, as a result, the Wolf (sunspot) number *(R)* dropped to about one half of its previous level. At the same time according to Catanian measurements the spot area *(A)* decreased to less than one third [15]. The coincidence of the solar and upper atmospheric events is interesting (see Fig. 3). Significant flares or distinctive events have not been observed during the time interval under consideration.

In 1964 solar activity had reached its absolute minimum, the average sunspot number being only 4 in April and July, 5 in September [15]. There were no visible spots on the Sun during 7—12 July and 16—28 Sept; average sunspot numbers being as low as 7—8—9 in April. It is by no means surprizing that the acceleration $\frac{dP}{dn}$ proved to be constant during these time intervals, and its absolute value in April 1964 was considerably larger than in July or in September. The correlation "more intensive solar activity — more intensive drag" approximately holds true, suggesting that with decrease in solar activity the upper atmosphere becomes cooler and shrinks closer to the earth so that at a given geometric altitude the density becomes less.

The comparison of $\frac{dP}{dn}$ values obtained for different time intervals demands, however, a lot of precaution because of the shift of the perigee and changes of the effective cross-sectional area as mentioned above. The general tendency — i.e. that acceleration contrary to all expectations is a *decreasing* function of time — has been proved by the convex shape (as seen from below) of the $\bar{P}(t)$ plot independently. From the graphically derived slopes of the curve at different points we find $\left|\frac{dP}{dn}\right|^*$ decreasing as well (see Table 5); even the arithmetical means of the $\left(\frac{dP}{dn}\right)^*$ and $\frac{dP}{dn}$ values derived during the four time intervals under consideration are practically equal (—0.00839 and —0.00861 s/rev respectively). Accordingly our results suggest that during 1963/64 air density around the altitude 250—260 km decreased — parallel with solar activity — to such an extent that the drag encountered by satellite 1960 $\varepsilon 3$ did not show a rising but a falling tendency considerably prolonging the lifetime of the satellite. It would be an interesting task to determine whether similar effects occurred in the motion of other satellites at the same time; unfortunately the Interobs material available did not allow such an investigation.

Studying all observations of 1960 $\varepsilon 3$ in 1963/64 it could be ascertained that in time intervals when at least 3 transits have been well observed (simultaneously from two stations), the rate of change of the period of revolution, if constant, can be determined with an error not exceeding 10—15%. Supposing that sudden variations occur in air density which has an effect on $\frac{dP}{dn}$ larger than this value, the date of change can be computed with an accuracy of possibly less than one day (in a fortunate case) or at least 1—2 days. Such time resolution is of interest when investigating the time delay of the influence of certain solar phenomena upon the upper atmosphere. It seems useful to extend the Interobs program in order to obtain material rich enough to set up actual correlations.

Konkoly Observatory, Budapest, September 1965.

APPENDIX

PROGRAM FOR ELLIOTT 803 COMPUTER TO CALCULATE THE SATELLITE'S POSITION IN SPACE FROM SIMULTANEOUS OBSERVATIONS

This program forms only the first part of a larger one to evaluate orbital elements directly from simultaneous observations (see [9]). The output of some data in excess is needed for the second part.

Input data

No. 1. number of tracking stations (less than 40);
No. 2. coordinates of tracking stations in a rectangular and in a geographic system:

$$(x^*, y^*, z^*, \lambda, \sin\varphi, \cos\varphi)_i \qquad (i = 1, 2, \ldots) \text{ (see [9])}$$

No. 3. number of days when observations have been performed (less than 200);
No. 4. hours, minutes and seconds of Greenwich sidereal time at 0^h GMT of days when observations have been performed;
No. 5. A_1 and A_2 (Parameters in

$$\alpha_m = \alpha_n + A_1 + A_2 \sin\alpha_n \operatorname{tg}\delta_n$$

$$\delta_m = \delta_n + A_2 \cos\alpha_n$$

where m is the year of observation,
n is the epoch of the catalogue or atlas);
No. 6. year, month, day and hour (integer numbers) of the first transit;
No. 7. identification number of the satellite (integer of maximum 5 figures);
No. 8. observing data: weight, time (h, m, s), identification number of the coordinate system (1 means equatorial, 2 means horizontal), right ascension or azimuth (h, m, s or °, ', ") declination or elevation (°, ') serial number of the tracking station according to No. 2, and serial number of the day according to No. 4. N.B. Maximum number of simultaneity groups (points in space) on each transit is 100. More than one observation from the same tracking station cannot be used in one simultaneity group.

Arriving to the next transit write all input data (No. 8) of the first observation, then 38(40(and the time of the new transit as in No. 6. In the case of a new satellite add 39(and the identification number of the satellite as in No. 7. After the very last observation add 12 zeros and 38(34( ).

Output

Every transit is printed out as a separate group. The first line gives: 1. the identification number of the satellite, 2. year, month, day and hour of the transit.
Line No. 2: time (in degrees) and θ (in degrees, see [9])of the first real observation;
Line No. 3: Σx_s^2, Σy_s^2, Σz_s^2 for the given transit. Spatial coordinates are tabulated below as follows:

$$x_{si}, y_{si}, z_{si}, R_{si}, n_i \qquad (i = 1, 2, \ldots)$$

where n_i is the number of all possible pairs in the simultaneity group when determining the satellite's position in space. The sign 5(at the end of every transit belongs to **Part II.** of the program.

After the last transit all observations neglected during the calculation are printed out using the following code:
Starting from horizontal coordinates

111111 indicates $\sin \delta > 0.999$
222222 indicates $|\sin t| > 0.99996$
333333 indicates $|\sin a| > 0.99996$ and

starting from equatorial coordinates

444444 indicates $\delta > 87°.5$
555555 indicates $|\sin a| > 0.99996$.

Numbers after these six-figure symbols give the serial number of the observation under consideration.

Further, whilst determining a position in space, those pairs of observations are not used where

$$|\mathrm{tg}\, a_K - \mathrm{tg}\, a_l| < 0.01$$

these are indicated by the symbol 666666 and k and l are printed out afterwards.

```
SETS LIHJUVKQWCD(2002)E(4)
SETV P(240)A(205)B(23)S(160)G(10)
   N(11)Z(400)
SETF TRIG ARCTAN SQRT
SETR 40

1) READ L
VARY I=1 : 1 : L
VARY H=0 : 40 : 6
READ P(I+H)
REPEAT H
REPEAT I
READ L
VARY I=1 : 1 : L
READ A(I)
READ A(I+1)
READ A(I+2)
A(I+2)=.01666666 * A(I+2)
A(I+1)=A(I+2)+A(I+1)
A(I+1)=.01666666 * A(I+1)
A(I)=A(I)+A(I+1)
A(I)=15 * A(I)
REPEAT I
READ G9
READ G10
N1=0
N4=0
N8=0
VARY I=1 : 1 : 4
READ EI
REPEAT I
2) READ V
C=1001
H=0
21) D2001=0
J=1
U=0
22) READ S(J)
VARY I=1 : 1 : 9
READ B(I)
REPEAT I
READ Q
READ W
JUMP IF J=1TO20
JUMP UNLESS B3=B13TO3
JUMP UNLESS B2=B12TO3
JUMP UNLESS B1=B11TO3
JUMP TO5
20) B11=B1
B12=B2
B13=B3
B3=.01666666 * B3
B2=B2+B3
B2=.01666666 * B2
B1=B1+B2
B20=15*B1
B1=1.00273791 * B20
B14=B1+A(W)
23) JUMP UNLESS B14>360TO4
B14=B14-360
JUMP TO23
4) B1=B14/180
B15=SIN B1
B16=COS B1
5) B1=P(Q) * B16
B2=P(Q+40) * B15
S(J+4)=B1-B2
B1=P(Q) * B15
B2=P(Q+40) * B16
S(J+5)=B1+B2
S(J+6)=P(Q+80)
JUMP IF B4=1TO16
JUMP IF B8>60TO10
JUMP IF B8>30TO9
JUMP IF B8>20TO8
JUMP IF B8>15TO7
```

```
JUMP IF B8>12TO6
B9=B9-5
JUMP TO10
6) B9=B9-4
JUMP TO10
7) B9=B9-3
JUMP TO10
8) B9=B9-2
JUMP TO10
9) B9=B9-1
10) B7=.01666666 * B7
B6=B7+B6
B6=.01666666 * B6
B5=B5+B6
B9=.01666666 * B9
B8=B9+B8
B5=B5/180
B6=COS B5
B5=SIN B5
B8=B8/180
B9=COS B8
B8=SIN B8
B1=P(Q+160) * B8
B2=P(Q+200) * B9
B2=B2*B6
B1=B1+B2
JUMP UNLESS B1>.999TO24
D(C)=111111
C=C+1
U=U+1
D(C)=U
C=C+1
JUMP IF C>1997TO34
JUMP TO22
24) B2=B1*B1
B2=1-B2
B2=SQRT B2
S(J+3)=B1/B2
B3=-B9*B5
B2=B3/B2
B3=MOD B2
JUMP UNLESS B3>.99996TO25
D(C)=222222
C=C+1
U=U+1
D(C)=U
C=C+1
JUMP IF C>1997TO34
JUMP TO22
25) B3=P(Q+160) * B1
B3=B8-B3
B7=B2*B2
B7=1-B7
B7=SQRT B7
B7=B2/B7
B7=ARCTAN B7
B7=180 * B7
JUMP IF B2>0TO11
JUMP IF B3>0TO12
B7=-180-B7
JUMP TO12
11) JUMP IF B3>0TO12
B7=180-B7
12) B1=B14-B7
B1=B1-P(Q+120)
26) JUMP IF B1<0TO14
13) JUMP IF B1<360TO15
B1=B1-360
JUMP TO13
14) B1=B1+360
JUMP TO26
15) B1=B1/180
B2=SIN B1
B3=MOD B2
JUMP UNLESS B3>.99996TO27
D(C)=333333
C=C+1
U=U+1
D(C)=U
C=C+1
JUMP IF C>1997TO34
JUMP TO22
27) B1=COS B1
S(J+1)=B2/B1
S(J+7)=S(J+4)*(J+1)
S(J+2)=1/B1
JUMP TO19
16) B7=.01666666*B7
B6=B6+B7
B6=.01666666*B6
B5=B5+B6
B5=15*B5
B9=.01666666*B9
B8=B8+B9
B7=B5/180
B6=COS B7
B7=SIN B7
B7=G10*B7
B6=G10*B6
B9=B8/180
B9=TAN B9
B7=B7*B9
B7=B7+G9
B5=B5+B7
B8=B8+B6
JUMP IF B8<90TO17
B8=180-B8
B5=B5+180
17) JUMP UNLESS B8>87.5TO28
D(C)=444444
C=C+1
U=U+1
D(C)=U
C=C+1
JUMP IF C>1997TO34
JUMP TO 22
28) JUMP UNLESS B5<0TO29
B5=360+B5
JUMP TO28
29) JUMP IF B5<360TO18
B5=B5-360
JUMP TO29
18) B8=B8/180
S(J+3)=TAN B8
B5=B5/180
B2=SIN B5
```

```
B8=MOD B2
JUMP UNLESS B8>.99996TO30
D(C)=555555
C=C+1
U=U+1
D(C)=U
C=C+1
JUMP IF C>1997TO34
JUMP TO 22
30) B5=COS B5
S(J+1)=B2/B5
S(J+7)=S(J+4)*S(J+1)
S(J+2)=1/B5
19) U=U+1
D2001=D2001+1
JUMP UNLESS D2001=1TO37
B22=B20
B23=B14
37) J=J+8
JUMP TO22
3) I=0
N2=0
N3=0
N5=0
N6=0
N7=0
K=1
L=K+8
31) G7=S(K)*S(L)
N5=N5+G7
G8=S(K)+S(L)
N6=N6+G8
G1=S(L+5)-S(K+5)
G1=G1-S(L+7)
G1=G1+S(K+7)
G2=S(K+1)-S(L+1)
G6=MOD G2
JUMP UNLESS G6<.1TO32
D(C)=666666
C=C+1
D(C)=K
C=C+1
D(C)=L
C=C+1
JUMP UNLESS C>1997TO35
LINE
D2002=C-1001
VARY C=1001 : 1 : D2002
PRINT D(C)
LINE
REPEAT C
C=1001
JUMP TO35
32) G1=G1/G2
G6=G1*G7
N7=N7+G6
G2=G1-S(K+4)
G3=G2*S(K+1)
G3=S(K+5)+G3
G5=G3*G7
N2=N2+G5
G2=G2*S(K+3)
G2=G2*S(K+2)
G2=G2+S(K+6)
G4=S(K)*G2
N3=N3+G4
G1=G1-S(L+4)
G1=G1*S(L+3)
G1=G1*S(L+2)
G1=S(L+6)+G1
G1=G1*S(L)
N3=N3+G1
I=I+1
35) L=L+8
JUMP IF L<JTO31
33) K=K+8
L=K+8
JUMP IF L<JTO31
D(H)=I
Z(4H+1)=N7/N5
Z(4H+2)=N2/N5
Z(4H+3)=N3/N6
B17=Z(4H+1)*Z(4H+1)
N1=N1+B17
B18=Z(4H+2)*Z(4H+2)
N4=N4+B18
B19=Z(4H+3)*Z(4H+3)
N8=N8+B19
B17=B17+B18
B17=B17+B19
Z(4H+4)=SQRT B17
H=H+1
S1=S J
J=1
JUMP TO20
38) LINE
PRINT V,5
SPACES 5
PRINT E1,4
PRINT E2,2
PRINT E3,2
PRINT E4,2
LINE
PRINT B22
PRINT B23
LINE
PRINT N1
PRINT N4
PRINT N8
LINE
VARY I=0 : 1 : H
VARY K=1 : 1 : 4
PRINT Z(4I+K)
REPEAT K
PRINT DI
LINE
REPEAT I
OUTPUT 21
OUTPUT 17
N1=0
N4=0
N8=0
D2001=0
H=0
JUMP TO22
34) C=C-1
```

```
LINES 3
CYCLE K=1001 : 1 : C
PRINT DK,6
LINE
REPEAT K
C=1001
JUMP TO22
39) READ V
JUMP TO22
40) VARY I=1 : 1 : 4
READ EI
REPEAT I
JUMP TO22
36) STOP
START 1
```

REFERENCES

[1] D. G. King-Hele and D. M. C. Walker: Space Research *2*, p. 918, 1961.
D. G. King-Hele: JBIS *19*, p. 374, 1964.
R. H. Merson and A. T. Sinclair: RAE Technical Rep. No 64036, 1964.
M. Ill: Наблюдения ИСЗ *3*, 1964.
М. Я. Маров: Космические исследования Вып *6* 1964.
[2] e.g. H. F. Michielson: PhS and E *6* No 6 1962.
[3] Z. Ceplecha: BAC *10* 41 1958.
C. Popovici: Наблюдения ИСЗ *1* 33 1962.
[4] Д. Е. Щеголев: Наблюдения ИСЗ *1* 40 1962.
[5] G. Veis: SAO Sp. Rep. No 133 1962.
[6] M. Ill: Baja Mitt. No. 1 1962.
[7] Ergebnisse der im Rahmen des Interobs-Programms abgehaltenen Kooperationswochen *1*, *2*, 1964, 1965.
[8] J. Bienewski: Biuletyn polskich . . . *8* 58 1963.
W. Baran: Artificial Earth Satellites. Observations and Investigations in Poland 105 1965.
I. Almár and M. Ill: Наблюдения ИСЗ *1* 46 1962.
[9] E. Illés and I. Almár: Наблюдения ИСЗ *3* 1964.
[10] Г. А. Устинов: Наблюдения ИСЗ *2* 19 1963
[11] e.g. D. G. King-Hele: Progress in the Astronautical Sciences *1* 1962. (The same equation used with two different coefficients.)
[12] Г. А. Чеботарев — Е. Н. Макарова: Бюллетень станции . . . No 40 34 1964.
[13] L. G. Jacchia: Smithsonian Astrophysical Observatory 1962 Dez 31.
[14] e.g. H. K. Paetzold and H. Zschörner: Space Research *1* p. 28 1960.
Н. П. Словохотова: Наблюдения ИСЗ *2* 3 1963.
[15] Quarterly Bulletin on Solar Activity, Eidgen Sternwarte Zürich
Солнечные данные

A kiadásért felel: Detre László Műszaki szerkesztő: Merkly László
A kézirat a nyomdába érkezett: 1965 XI. 16 — Példányszám: 700 — Terjedelem: 2,8 (A5) ív

66.61585 Akadémiai Nyomda, Budapest — Felelős vezető: Bernát György

A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST-SZABADSÁGHEGY

Nr. 60

I. ALMÁR and E. ILLÉS–ALMÁR

PHOTOELECTRIC OBSERVATIONS OF NOVA HER 1963

BUDAPEST, 1966

PHOTOELECTRIC OBSERVATIONS OF NOVA HER 1963

by

I. ALMÁR and E. ILLÉS—ALMÁR

Nova Herculis 1963, discovered on Febr. 6 1963 by E. Dahlgren, was observed photoelectrically in three colours from Febr. 9 1963 to Oct. 2 1964 at the Konkoly Observatory. Magnitudes, reduced to a single comparison star and one photometric system, were compared with other photoelectric observations taken from the literature. The plotting of a composite light curve proved to be possible, at least in the first three months. Rapid fluctuations in brightness and colour have been suspected already in 1964 and confirmed later by photoelectric observations at the Asiago Observatory. Breaks discovered on the colour-index and on the logarithmic light curves were confronted with spectroscopic results.

OBSERVATIONS

The observations were made using the 24″ Newtonian reflector, equipped with a photoelectric photometer, containing an EMI photomultiplier and UG1, BG12 + GG13 and GG11 filters in ultraviolet, blue and yellow light respectively. In the second half of April 1963 the original silver coating of the mirror was replaced by an aluminium one. This was the only considerable change in the equipment used during the 43 nights when altogether 297 y, 293 b—y and 262 u—b measurements of the nova have been obtained.

In the first 11 nights only BD + 42°3035 = HD167965 = HR6845 was observed as a comparison star. Later we decided to use pairs of near-by stars with different colour-indices for making easier the determination of the extinction coefficients. Table I gives the magnitudes and colours of the comparison stars in the UBV system. Fig. 1 is an identification chart.

Table I

BD		V	B—V	U—B
+42° 3035	A	+5.55	−0.13	−0.49
+41° 3010	B	+8.47	+0.37	+0.02
+42° 3024	C	+8.77	+0.88	+0.64
	D	+10.51	+0.99	+0.74
	F	+10.93	+0.36	+0.11

The components of the double star BD + 41°3010 = ADS11174 could be seen separated in the guiding telescope on very clear nights but the diaphragm

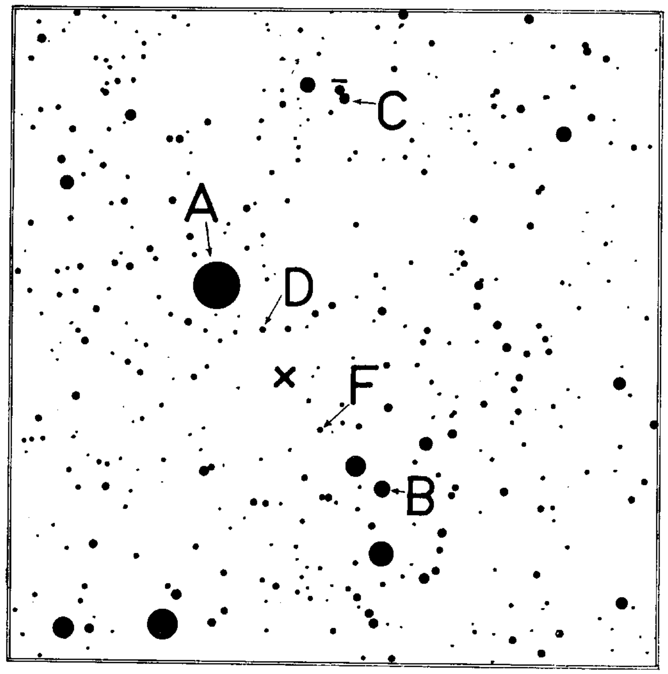


Fig. 1. The identification chart of Nova Her 1963 (cross) with the comparison stars.

used for the photoelectric measures greatly exceeded their separation. All magnitudes and colours of Nova Her 1963 relative to BD $+42°3035$ are listed in Table II in our "1963 IX--XII" photometric system (see later).

Table II

J. D. 2438 ...	Δy	$\Delta(b-y)$	$\Delta(u-b)$	J. D. 2438 ...	Δy	$\Delta(b-y)$	$\Delta(u-b)$
069.615	—1.386	+0.066	—	078.607	—0.813:	+0.085:	—0.313:
.617	—1.453	+0.136	—0.324	.611	—0.841:	+0.126:	—0.329:
.623	—1.444	+0.114	—0.328	.617	—0.750:	+0.081:	—0.336:
.637	—1.403	+0.101	—0.326	.620	—0.814:	+0.092:	—0.318:
.642	—1.422	+0.116	—0.330				
.657	—1.402	+0.082	—0.301	082.601	—0.389	+0.085	—0.329
.662	—1.423	+0.105	—0.298	.605	—0.398	+0.111	—0.337
.665	—1.367	+0.052	—0.299	.609	—0.374	+0.110	—0.375
.668	—1.422	+0.109	—0.301	.610	—0.352	+0.077	—0.361
.675	—1.409	+0.091	—0.295	.612	—0.346	+0.066	—0.343
.677	—1.412	+0.100	—0.301				
.681	—1.419	+0.098	—0.303	090.570	—0.477	+0.061	—0.271
.687	—1.417	+0.103	—0.308	.571	—0.474	+0.051	—0.268
.689	—1.337	+0.022	—0.299	.576	—0.465	+0.046	—0.282
.692	—1.415	+0.109	—0.311	.577	—0.471	+0.042	—0.269
.698	—1.395	+0.079	—0.314	.579	—0.474	+0.053	—0.296
.701	—1.417	+0.099	—0.313				
.703	—1.411	+0.089	—0.307	104.579	+0.442:	—0.038:	—0.275:

J. D. 2438 . . .	Δy	$\Delta(b-y)$	$\Delta(u-b)$
104.584	+0.450	−0.066	−0.299
.586	+0.426	−0.045	−0.261
.591	+0.364	−0.031	−0.254
.592	+0.424	−0.089	−0.310
113.563	+0.610:	−0.098:	−0.247
.568	+0.638	−0.109	−0.244
.569	—	—	−0.246
.573	+0.609	−0.074	−0.245
.575	+0.645	−0.103	−0.258
.578	+0.618	−0.078	−0.257
.580	+0.627	−0.081	−0.266
114.564	+0.870	−0.134:	−0.246:
.569	+0.825	−0.099	−0.253
.570	+0.829	−0.110	−0.253
.572	+0.828	−0.114	−0.245
.576	+0.838	−0.119	−0.255
.578	+0.834	−0.111	−0.255
.581	+0.832	−0.099	−0.256
.583	+0.838	−0.105	−0.258
118.549	+0.528	−0.082	−0.233
.551	+0.540	−0.077	−0.249
.568	+0.527	−0.062	−0.271
.569	+0.534	−0.082	−0.235
.573	+0.533	−0.072	−0.242
126.539	+1.144	−0.175	−0.223
.541	+1.146	−0.170	−0.233
.545	+1.147	−0.167	−0.234
.547	+1.160	−0.173	−0.242
.551	+1.176	−0.197	−0.238
.553	+1.176	−0.143	−0.217
.555	+1.178	−0.187	−0.235
159.515	+1.775	+0.110	−0.038
.516	+1.781	—	—
.522	+1.738	+0.125	−0.076
.524	+1.759	+0.136	−0.073
.527	+1.783	+0.129	−0.038
.534	+1.758	+0.109	−0.077
.536	—	—	−0.070
.544	+1.775	—	—
.549	+1.793	+0.062	−0.092
.553	+1.779	+0.063	−0.059
.555	+1.756	+0.059	−0.072
.562	+1.773	+0.213	−0.186
.565	+1.772	+0.084	−0.066
.567	+1.770	+0.079	−0.060
160.444	+1.849	+0.088	−0.078
.446	+1.841	+0.074	−0.046
.452	+1.832	+0.081	−0.026
.454	+1.847	+0.074	−0.049
180.404	+2.358	+0.268	—

J. D. 2438 . . .	Δy	$\Delta(b-y)$	$\Delta(u-b)$
180.405	+2.274	+0.364	—
.410	+2.265	+0.311	—
.417	—	—	−0.004
.417	—	—	+0.005
.421	—	—	+0.006
.422	—	—	+0.017
.427	+2.291	+0.273	+0.032
.428	+2.319	+0.247	+0.028
.430	+2.317	+0.263	+0.016
.431	+2.353	+0.234	+0.003
197.486	+2.459	+0.339	+0.094
.493	+2.421	+0.396	—
.495	+2.407	+0.372	+0.082
.509	+2.477	+0.354	+0.062
.511	+2.463	+0.335	+0.097
.519	+2.457	+0.380	+0.104
.521	+2.505	+0.356	+0.145
.523	+2.478	+0.362	+0.088
220.375	+2.698	+0.514	+0.252
.377	+2.691	+0.511	+0.276
223.353	+2.778:	+0.519:	+0.272
.356	+2.746:	+0.554:	+0.229
.362	+2.762	+0.526	+0.291
.364	+2.732	+0.551	+0.287
.369	+2.751	+0.565	+0.275
.371	+2.828:	+0.462:	+0.278
.373	+2.728	+0.541	+0.297
.379	+2.740	+0.556	+0.293
.381	+2.752	+0.521	+0.278
224.504	+2.710	+0.599	+0.279
.507	+2.716	+0.576	+0.307
.512	+2.697	+0.606	+0.280
.515	+2.709	+0.577	+0.277
.539	+2.760	+0.576	+0.194
.547	+2.721	+0.548	+0.348
.549	+2.740	+0.633	+0.258
236.506	+2.872	+0.701	—
.514	+2.871	+0.694	+0.323
.519	+2.857	+0.683	+0.274
.521	+2.860	+0.697	+0.380
.526	+2.855	+0.709	—
.528	—	—	+0.226
.530	+2.870	+0.673	—
.531	—	—	+0.301
241.519	+2.925	+0.673	+0.391:
.521	+2.953	+0,607	+0.437:
.547	+2.904	+0.664	+0.446:
.549	+2.946	+0.654	+0.542:
253.477	+3.022	+0.727	+0.490
.481	+3.004	+0.841	+0.385

J. D. 2438 . . .	Δy	$\Delta(b-y)$	$\Delta(u-b)$
253.508	+3.044:	+0.591:	+0.339:
.511	+3.020:	+0.641:	+0.292:
.519	+3.016	+0.612	+0.344
.526	+3.045:	+0.608:	+0.285:
261.508	+3.107	+0.898:	+0.358:
.515	+3.064	+0.930	+0.374
.520	+3.102:	+0.919:	+0.379
.525	+3.110	+0.915:	+0,403:
285.415	+3.369	+1.023:	+0.379:
.430	+3.388	+1.047:	+0.463:
292.413	+3.464:	+1.083:	+0.359:
.417	+3.416	+1.110	+0.416
422	+3.404	+1.116	+0.421
.427	+3.419	+1.097:	+0.388:
305.398	+3.478	+1.107	+0.457
.403	+3.568	—	—
.409	—	—	+0.613:
.416	+3.481	+1.139	+0.419
322.343	+3.710	+1.226	+0.436
.348	+3.725	+1.214	+0.453
.354	+3.708	+1.231	+0.548
.359	+3.701	+1,180	+0.473
338.297	+3.810	+1.350	+0.409
.302	+3.802	+1.372	+0.353
.306	+3.860	+1.325	+0.329
.312	+3.847	+1.326	+0.398
.317	+3.868	+1.204	+0.452
345.278	+3.862	+1.383	+0.394
.285	+3.901	+1.387	+0.242
.291	—	—	+0.485
.297	+3.891	+1.319	+0.467
302	+3.876	+1.276	+0.571
352.290	+3.965	+1.365	+0.388:
.297	+3.950	+1.338	+0.438
.303	+3.993	+1.359	+0.404
.311	+3.946	+1.396	+0.339
371.199	+4.114	+1.432:	+0.303:
.205	+4.121	+1.385	+0.356
208	+4.104	+1.425	+0.384
.213	+4.117	+1.412	+0.356
.217	+4.049:	+1.502:	+0.380
.222	+4.170:	+1.372:	+0.320:
387.185	+4.223	+1.476:	+0.407:
.192	+4.219	+1.441	+0.262
.197	+4.223	+1.397	+0.406
.204	+4.201	+1.502	+0.380
.209	+4.249	+1.409	+0.351
.214	+4.250	+1.433:	+0.358:
439.639	+4.656	+1.512:	+0.442:
.662	+4.639	+1.467:	+0.368:
.670	+4.604	+1.492	+0.387
.675	+4.629	+1.529	+0.318
.681	+4.668	+1.458:	+0.275:
473.599	+4.970	+1.566	+0.130
.604	+4.961	+1.587	+0.261
.609	+4.959	+1.553	+0.173
492.542	+5.047	+1.480:	+0.270:
.549	+5.199	+1.485	+0.178
.555	+5.031	+1.257	+0.352
.561	+5.137	+1.508	+0.293
.565	+5.073	+1.482	+0.221
.571	+5.094	+1.382	+0.351
497.503	+5.200	+1.317	—
.506	+5.081	+1.411	—
.509	+5.063	+1.414	—
.512	+5.156	+1.346	—
.524	+5.166	+1.347	—
.527	+5.153	+1.468	—
.528	+5.168	+1.336	—
.535	+5.149	+1.473	—
.538	+5.201	+1.333	—
.541	+5.187	+1.288	—
.547	+5.088	+1.417	—
.550	+5.152	+1.352	—
.553	+5.138	+1.446	—
.562	+5.177	+1.451	—
.564	+5.116	+1.424	—
.568	+5.206	+1.397	—
.578	+5.222	+1.380	—
.580	+5.239	+1.332	—
.588	—	—	+0.271
.589	+5.142	+1.322	—
.593	+5.162	+1.381	—
.595	+5.172	+1.288	—
.604	+5.154	+1.377	—
.607	+5.135	+1.417	—
.610	+5.194	+1.450	—
522.429	—	—	+0.064
.432	+5.311	+1.441	—
.436	+5.321	+1.419	+0.068
.438	+5.292	+1.463	+0.223
.443	+5.305	+1.394	+0.263
.535	+5.286	+1.468	+0.193
.539	+5.347	+1.384	—
.540	+5.384	+1.374	—
.545	—	—	+0.135
.550	+5.391	+1.400	—
.551	+5.362	+1.323	—
.565	+5.335	+1.468	—
.566	+5.371	—	—

J. D. 2438...	Δy	$\Delta(b-y)$	$\Delta(u-b)$
524.495	+5.349	+1.328	+0.294
.498	+5.353	+1.371	+0.196
.555	+5.365	+1.269	+0.432
.560	+5.477	+1.219	+0.336
.563	+5.429	+1.345	+0.269
528.473	+5.398	+1.253	+0.225
.480	+5.451	+1.400:	−0.109:
.492	+5.359	+1.356	+0.136
.502	+5.354	+1.370	+0.155
.511	+5.393	+1.411	+0.040:
.514	+5.398	+1.348	+0.179
.520	+5.412	+1.343	+0.168
.526	+5.368	+1.366	+0.198
.530	+5.401	+1.420	+0.054
.538	+5.381	+1.412	+0.113
.545	+5.388	+1.396	+0.168
529.477	+5.418	+1.350	+0.422
.484	+5.415	+1.381	+0.160
.490	+5.403	+1.330	+0.152
.497	+5.425	+1.318	+0.176
.500	+5.432	+1.360	+0.141
549.436	+5.613:	+1.251:	+0.131:
583.378	+5.947:	+1.209:	+0.003
.385	+5.790	+1.459	+0.302
.391	+5.892	+1.477	−0.029
.399	+5.852	+1.394	0.000
.407	+5.866	+1.261	+0.212
.416	+5.903:	+1.233:	+0.120:
586.365	—	—	+0.038
.372	+5.772	+1.246	+0.066
.375	+5.769	+1.155	+0.157
.378	+5.795	+1.147	—
.382	+5.728	+1.181	+0.130
.384	+5.727	+1.284	+0.177
.389	+5.792	+1.253	+0.192
.391	+5.805	+1.183	—
.393	—	—	+0.208
.395	+5.780	+1.271	+0.162
.399	+5.784	+1.228	+0.148
586.403	+5.790	+1.235	+0.085
.407	+5.786	+1.189	+0.058
.409	+5.769	+1.270	+0.068
.411	+5.782	+1.289	—
.415	+5.837	+1.248	+0.007
.420	+5.795	+1.260	+0.137
.422	—	—	+0.222
.424	+5.808	+1.194	+0.076
.427	+5.804	+1.178	+0.131:
.430	+5.817	+1.144	+0.044:
.433	+5.803	+1.249:	+0.062
607.379	+5.835	+1.162	+0.042
.388	+5.855	+1.137	−0.018:
.393	+5.917	+1.172	+0.254
.396	+5.916	+1.348	−0.040
.404	+5.924	+1.130	+0.078
.407	+5.867	+1.185	+0.046
.415	+5.821	+1.169	+0.240
.419	+5.843	+1.228	+0.047
.427	+5.942	+1.147:	+0.105:
615.334	+6.048	+1.185	+0.143
.339	+6.040	+1.231	−0.004
.347	+5.971	+1.351	−0.031
.352	+6.056	+1.224	+0.098
.396	+5.976	+1.296	+0.114
.401	+6.070	+1.260	+0.059
.407	+6.018	+1.322	+0.042
.412	+5.986	+1.352	+0.241
.443	+6.103	+1.318	+0.114
.449	+6.104	+1.182	—
.453	+5.998	+1.303	—
.483	+5.993	+1.084	—
.488	+5.949	+1.277	—
.505	+5.993	+1.055	—
.510	+6.063	+1.030:	—
671.298	+6.276	+1.937:	+0.195:
.306	+6.210	+1.098	+0.037
.313	+6.269	+1.088	−0.012
.323	+6.174	+1.078	+0.075
.332	+6.286	+1.150	−0.076
.341	+6.260	+1.076	−0.053

REDUCTION

The reduction of a long series of medium-band width photoelectric observations of a nova to a homogeneous photometric system is hampered by the fact, that the necessary changes over to fainter and fainter comparison stars may be accompanied by gradual changes in the photometric system. Nevertheless it is unadvisable to rely on a single comparison star for a large interval of magnitudes because this would reduce the accuracy of the measurements.

Average values of the principial coefficients (k' and k'_c) and second-order coefficients (k''_c) of the atmospheric extinction were determined separately for each observing season using all material available at the observatory. Observed magnitudes and colour-indices were corrected for atmospheric extinction (differential extinction included) according to the relations [1]:

$$\Delta y_0 = \Delta y - k_y \Delta X$$
$$\Delta(b-y)_0 = \Delta(b-y)J_x - k'_{by}\Delta X$$
$$\Delta(u-b)_0 = \Delta(u-b)G_x - k'_{ub}\Delta X$$

The resulting extra-atmospheric quantities are not directly comparable because of the lack in uniformity of the whole photometric system. As a constant reference source of light was not available, the transformation coefficients ε, μ, ψ had to be derived by means of several Johnson standard stars. Colours and/or magnitudes of 2–6 suitably chosen standard stars were measured on 9 nights, together with the determination of UBV magnitudes of the comparison stars (see Table I). Average transformation coefficients are given in Table III as a function of time.

Table III

	1963			1964	
	II–IV	V–VIII	IX–XII	I–VI	VII–XII
ε	–0.15	–0.15	–0.15	–0.15	–0.15
μ	0.86	1.02	1.02	1.00	1.00
ψ	0.84	1.08	1.00	0.95	0.91

We decided to reduce all observations to the photometric system of our telescope from Sept. to Dec. 1963 as standard. Data reduced to this photometric system are marked with u, b, y. The transformation to the UBV system which involves a considerable shift in the effective wave-length, is inadmissible in peculiar stars like novae, where spectral deviations from blackbody characteristics are so pronounced. We hoped that a natural system of our own would be more realistic in this particular case. Magnitudes and colours transformed to the "1963 IX–XII" system are given by

$$\Delta y = \Delta y_0$$

$$\Delta(b-y) = \frac{\mu}{1.02}\Delta(b-y)_0$$

$$\Delta(u-b) = \psi\Delta(u-b)_0$$

where the coefficients come from Table III.

Finally however a unified magnitude and colour sequence of the 5 comparison stars in the new photometric system was needed. It was obtained by making two kinds of observations: 1. special connections to Johnson standard stars on 8 nights as mentioned above, 2. simultaneous observations of comparison stars (sometimes alternately with the nova itself) on 30 nights. Both kinds of results were reduced to the "1963 IX—XII" system using the known ε, μ, ψ values. Suitable sequences of magnitudes and colours of the 5 comparison stars were established by trial and error. Table IV gives the result in respect to BD $+42°3035$ which was the comparison star used almost exclusively by all observers of Nova Her 1963.

Table IV

	y	$b-y$	$u-b$
B—A	+2.989	+0.494	+0.508
C—A	+3.369	+0.987	+1.125
D—A	+5.119	+1.095	+1.225
F—A	+5.452	+0.480	+0.604

Table II contains heliocentric Julian Dates of the observations and all y, $b-y$ and $u-b$ values relative to BD $+42°3035$. Observations in respect to other comparison stars were transformed according to Table IV; double (simultaneous) measurements, after being reduced to BD $+42°3035$, are simply averaged. Uncertain values are denoted by a colon. Table V contains for every separate night, mean values of Δy, $\Delta(b-y)$ and $\Delta(u-b)$; they are plotted in figures 2 and 3.

Standard deviations on a night of moderate quality in 1963 are $0^{m}.025$ in yellow, $0^{m}.006$ in blue, $0^{m}.018$ in ultraviolet and in 1964 $0^{m}.026$ in yellow, $0^{m}.048$ in blue and $0^{m}.068$ in ultraviolet. The lack of observations in April 1963 is due to the lengthy delay of the new coating of the mirror.

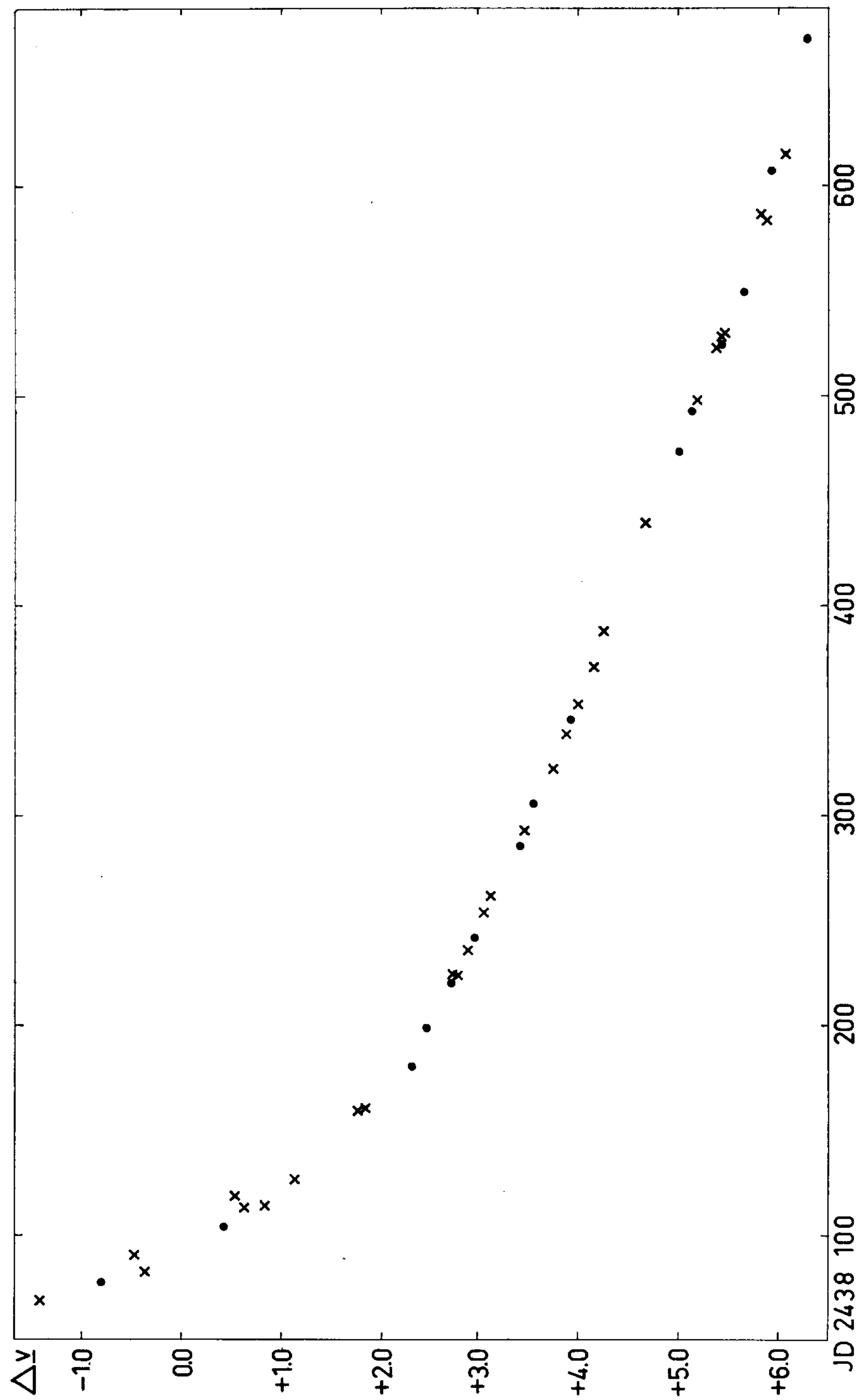


Fig. 2. Magnitude differences between Nova Her 1963 and BD + 42°3035 in yellow according to Table V, obtained at the Konkoly Observatory. Uncertain observations are denoted by points.

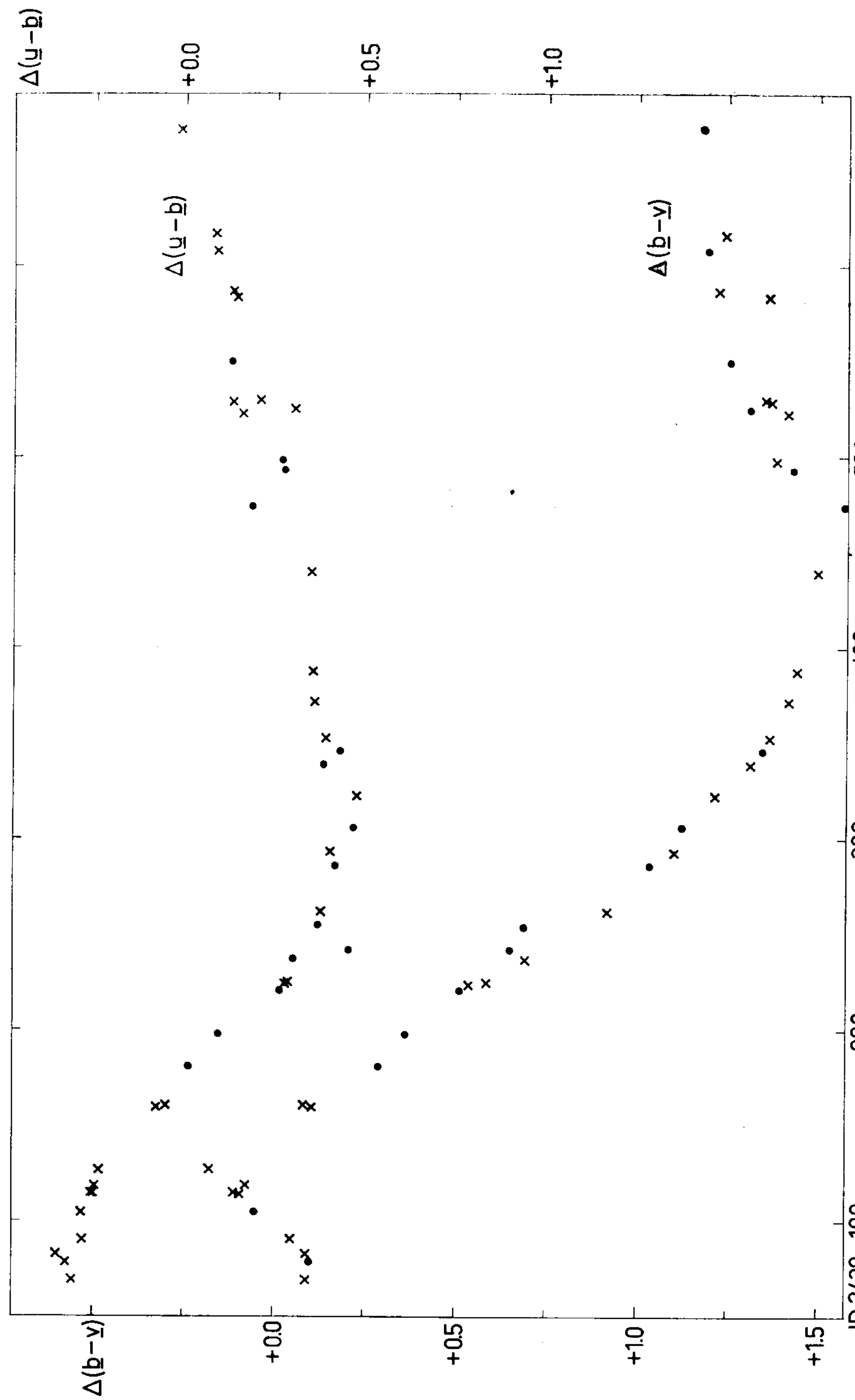


Fig. 3. Colour-index curves according to Table V, obtained at the Konkoly Observatory. Uncertain observations are denoted by points.

Table V.

J. D. 2438 ...	Δy	$\Delta(b-y)$	$\Delta(u-b)$
069.667	—1.409	+0.093	—0.309
078.614	—0.804:	+0.096:	—0.324
082.607	—0.372	+0.090	—0.349
090.575	—0.472	+0.051	—0.277
104.586	+0.419:	—0.055:	—0.280
113.573	+0.625	—0.090	—0.252
114.574	+0.837	—0.110	—0.253
118.562	+0.532	—0.075	—0.246
126.546	+1.161	—0.173	—0.232
159.543	+1.770	+0.106	—0.076
160.449	+1.842	+0.079	—0.050
180.421	+2.311:	+0.280:	+0.013:
197.508	+2.458:	+0.362:	+0.097:
220.376	+2.695:	+0.512:	+0.264:
223.368	+2.753	+0.537	+0.278
224.525	+2.722	+0.588	+0.281
236.521	+2.864	+0.693	+0.301:
241.534	+2.932:	+0.649:	+0.454:
253.504	+3.021	+0.689:	+0.373:
261.517	+3.096	+0.918	+0.378
285.423	+3.379:	+1.035:	+0.421: .
292.420	+3.425	+1.105	+0.404
305.407	+3.509:	+1.123:	+0.473:
322.351	+3.711	+1.213	+0.478
338.307	+3.837	+1.315	+0.388:
345.291	+3.882:	+1.345:	+0.432:
352.300	+3.963	+1.365	+0.393
371.211	+4.113	+1.417	+0.358
387.200	+4.228	+1.441	+0.356
439.665	+4.639	+1.497	+0.356
473.604	+4.963:	+1.569:	+0.188:
492.557	+5.097:	+1.428:	+0.278:
497.556	+5.159	+1.382	+0.271:
522.475	—	—	+0.158
.506	+5.337	+1.413	—
524.534	+5.395:	+1.306:	+0.305
528.512	+5.391	+1.369	+0.132
529.490	+5.419	+1.348	+0.210
549.436	+5.613:	+1.251:	+0.131:
583.396	+5.865	+1.362	+0.141
586.402	+5.786	+1.220	+0.134
607.403	+5.880:	+1.189:	+0.089
615.380	—	—	+0.086
.421	+6.025	+1.238	—
671.319	+6.246:	+1.174:	—0.012

DISCUSSION

a) Beside the numerous visual and photographic observations [2, 3, 4, 5, 6, 7, 8, 9] a lot of excellent photoelectric measurements of Nova Her 1963 has been published by several observers up to the present time [10, 11, 12, 13, 14, 15]. Though their photometric system may be entirely different, it is tempting to try a comparison of the light curves obtained. The greatest number of observations of the nova was accomplished in the first 3 months after its maximum:

Peking [14]	1963 Febr. 17 — Nov. 19
Tokyo [13]	1963 Febr. 9 — Apr. 21
Leiden [12]	1963 Febr. 22 — Oct. 18
Asiago [10]	1963 Febr. 10 — May 25
Vilnius [11]	1963 Febr. 12 — March 22
(Budapest	1963 Febr. 9 — 1964 Oct. 2)

In the first two cases measurements are directly expressed relative to BD + 42°3035. Nevertheless UBV magnitudes and colours of this near-by star are given by all the observers:

	V	B−V	U−B
Peking	5.57	−0.15	−0.42
Tokyo	5.54	−0.12	−0.53
Leiden	5.602	−0.065	−0.447
Asiago	5.60	−0.19	−0.39
Vilnius	5.62	−0.14	−0.39
(Budapest	5.55	−0.13	−0.49)

In the other three cases it was easy to reduce UBV values of the nova to u, b, y varying the magnitudes of BD + 42°3035 and a reasonable coincidence could be obtained. Figure 4 gives the composite light curves compiled from measurements made in different photometric systems in the first 66 days after the nova's maximum. The complicated and irregular light variation of the nova (frequently averaged out in visual or photographic light curves) can be traced from the very beginning. The remarkable coincidence of the observations seems to be the consequence of the relatively flat intensity distribution in the spectrum of the nova on these days, whereby the intensity measurements are insensitive to changes in the effective wave length.

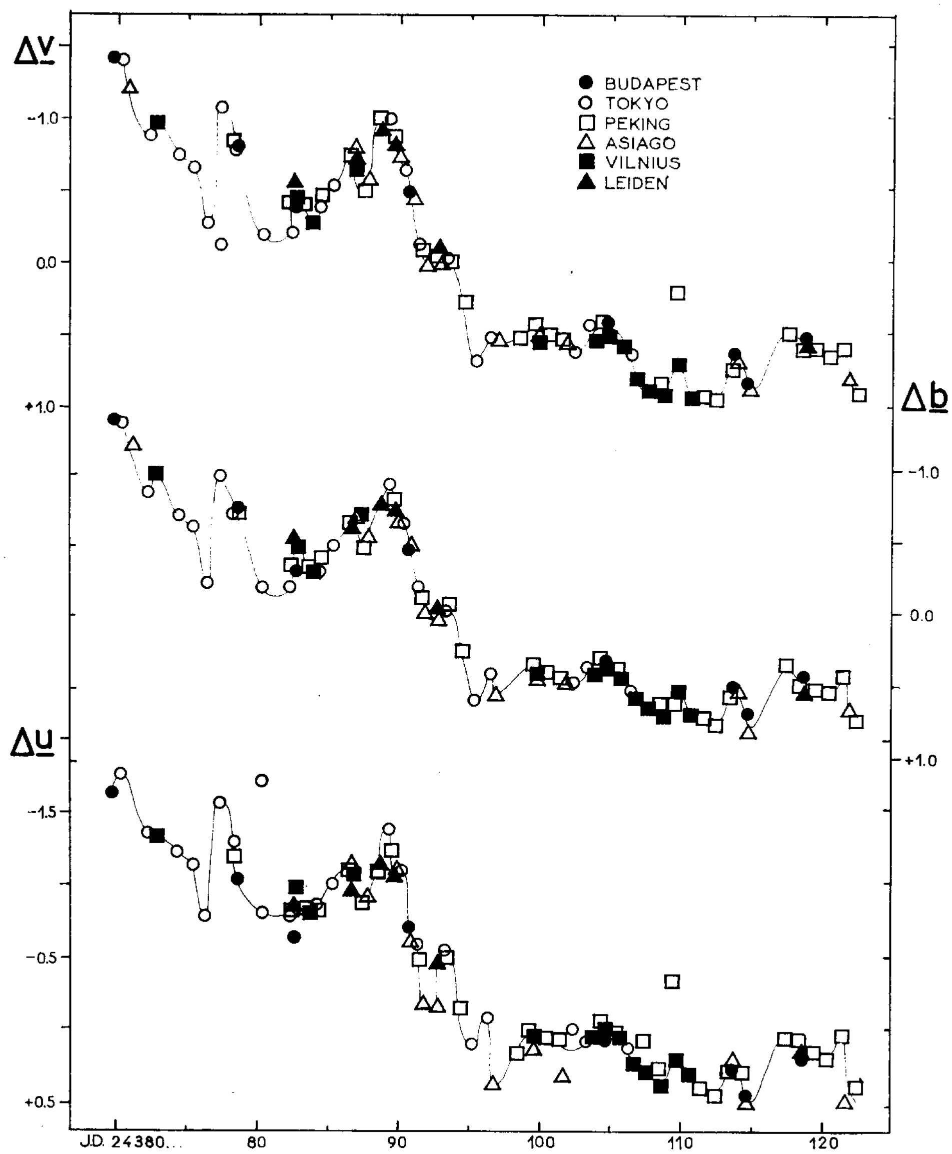


Fig. 4. All magnitude differences between Nova Her 1963 and BD + 42°3035 in ultra-violet, blue and yellow, obtained at different observatories before Apr. 4 1963.

It is worth while noting that these very pronounced light fluctuations, with a pseudo-period of from 1.5 to 3 days, apparently did not have an effect on the colour-indices (see Fig. 3). At the beginning of April there was a break on the $b-y$ colour curve and about May 10 the character of the light curves in all the three colours changed, i.e. light fluctuations came to a sudden end.

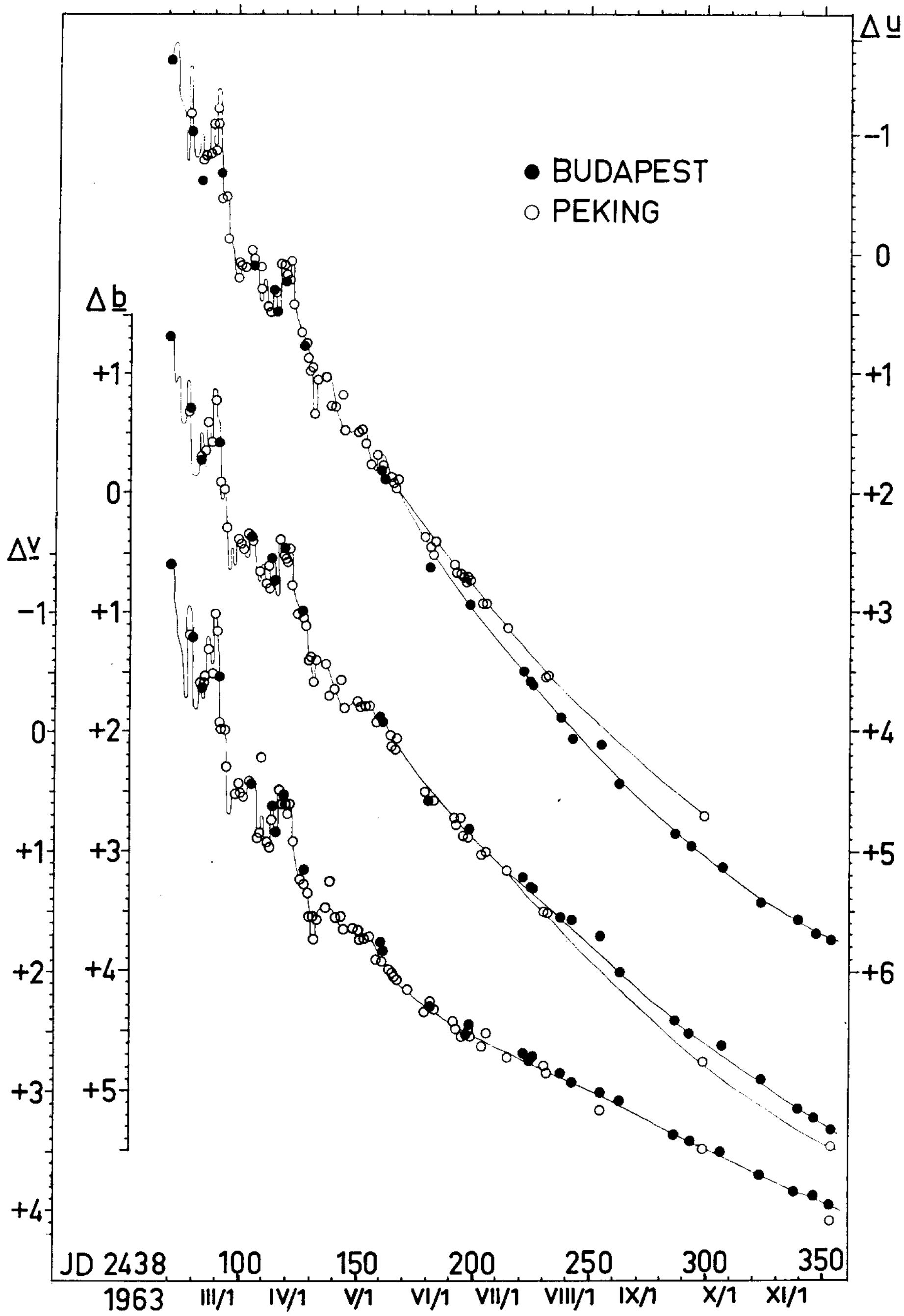


Fig. 5. Magnitude differences between Nova Her 1963 and BD + 42°3035 obtained at the Budapest and Peking observatories. The solid lines were plotted following Fig. 4.

From that point on there is no coincidence between our light curves and those published in the literature; the role of the effective wave length in the photometry of the nova became decisive. One exception is to be emphasized. The filters used at the Peking Astronomical Observatory being identical with ours, our findings also agree in the later part of the corresponding light curves (Fig. 5). This experience shows that medium-band width photoelectric observations of even such peculiar stars as novae are comparable in certain cases. The absence of fluctuations on this second part of the light curves has been stated also by *Breckinridge* [15].

In the third part of the light curves other photoelectric observations are missing for comparison. In order to study possible fluctuations longer series of observations were carried out in 1964. During several nights quick, irregular variations were found. The curves reproduced in Fig. 6 are typical examples. In the diagrams magnitudes and colours in respect to both comparison stars are plotted separately, showing the variation in the mutual relative y, $b-y$, $u-b$ values of the comparison stars too. The existence of quick brightness and colour fluctuations seems to be established. More confidence was given to the reality of this phenomenon from the fact that one year later rapid changes in different colours were observed also at the Lick Observatory from where we have received the following private communication from Dr. G. Chincarini: "During the night June 29/30 1965 the nova was observed with the 24" reflector of the Lick Observatory in order to get measurements in the u, b, y colours. On this night the integrator with 10 sec integration time was used. Since the signal was not as constant as for normal stars the nova was kept on the diaphragm for about 1^h. Changes in u and b magnitudes were observed. Because of the good quality of the sky and the constancy of the equipment (checked as usual with a radium source) we accepted it as a fact. The next night, I had the telescope, was on July 7/8 1965. The star was then observed for 90 min. almost only in the u colour and the telescope was checked by the radium source every 8 min. A direct current amplifier was used. The night was photoelectrically good and the sky was measured every 15 min. The brightness of the sky was however very low. In figure 7 the u and b magnitudes are given in an arbitrary scale. The nova seems to show rapid casual fluctuations. However the observations are not enough to see if any periodicity is present."

One of us had the opportunity to continue the photoelectric observations of Nova Her 1963 with a photometer attached to the 122 cm reflector of the Asiago Astrophysical Observatory (Italy). The light curves (without a filter) on 16 and 28 March 1966 indicate in addition to short-period fluctuations the presence of a minimum of approximately 40 min. duration and 0.1 mag. depth, similar to partial eclipses of Algol type binaries. (Observations: Table VI, composite light curve: Fig. 8.) The periodicity of the phenomenon has not been ascertained [31].

Dr. G. Chincarini and S. Howard announce [32], however, that according to new observations carried out at Lick Observatory on the nights April 20, 21, 22 and 27 1966 the light curve of the nova is characterized by *a)* fluctuations of amplitude between 0.2 and 0.1 magnitudes and lasting from 5 to 50 minutes, *b)* overimposed a few minima with amplitude of 0.1 — 0.2 magnitudes and lasting only 15 minutes.

More observations are urgently needed in order to understand the nature of the fluctuations.

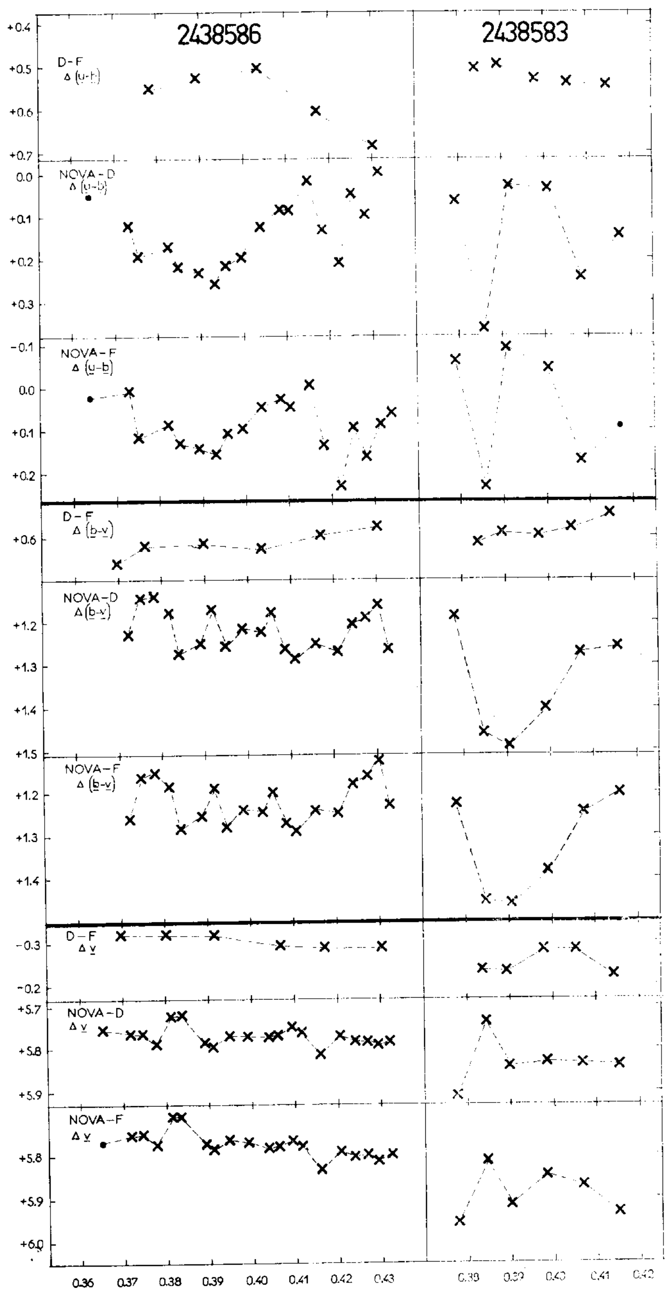


Fig. 6. Examples of rapid fluctuations in brightness and colour of the nova in 1964. Relative light and colour curves of the near-by comparison stars are published as control observations.

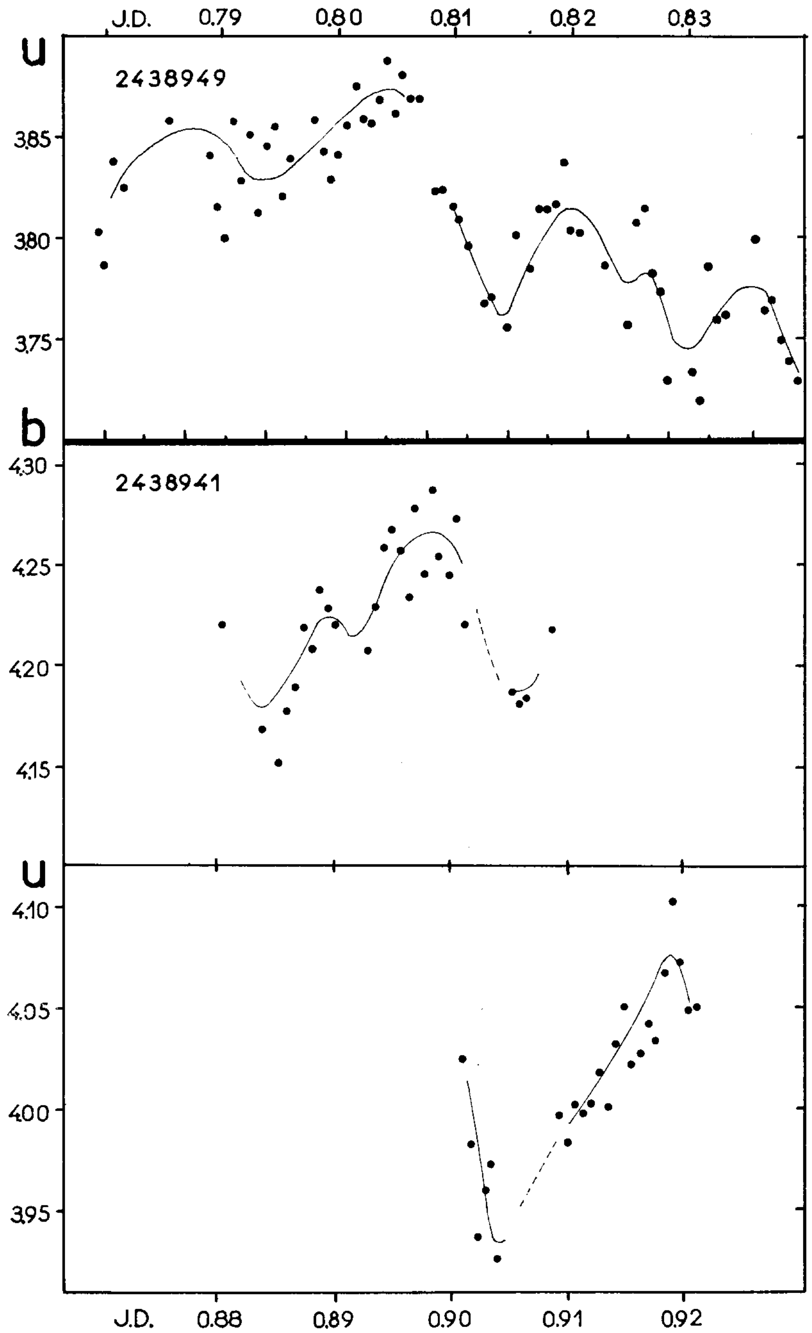


Fig. 7. Dr. Chincarini's observations at the Lick Observatory in blue and ultraviolet, in 1965.

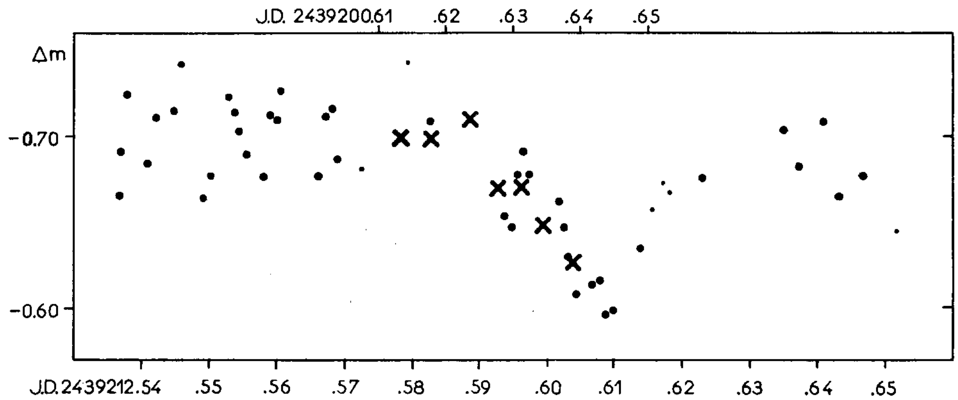


Fig. 8. The light curve of Nova Her 1963 composed from observations on 16 and 28 March 1966 carried out at the Asiago observatory. (16 March: crosses, 28 March: points)

Table VI

J. D. 2439 . . .	Δm
200.6134	−0.699
.6176	−0.698
.6235	−0.709
.6276	−0.669
.6311	−0.670
.6346	−0.648
.6389	−0.627:
212.5365	−0.665
.5369	−0.690
.5376	−0.724
.5407	−0.684
.5420	−0.710
.5448	−0.714
.5458	−0.741
.5490	−0.663
.5501	−0.676
.5529	−0.722
.5539	−0.713
.5545	−0.702
.5556	−0.689
.5580	−0.676
.5591	−0.711
.5598	−0.709
.5605	−0.726
.5661	−0.675
.5671	−0.711
.5678	−0.715
.5688	−0.686
.5723	−0.680:
.5793	−0.742:
.5827	−0.708
.5938	−0.653
.5949	−0.648
.5956	−0.678
.5966	−0.691
.5973	−0.677
.6018	−0.662
.6025	−0.647
.6032	−0.630
.6043	−0.608
.6070	−0.615
.6078	−0.616
.6088	−0.597
.6098	−0.599
.6140	−0.634
.6157	−0.657:
.6171	−0.672:
.6182	−0.667:
.6230	−0.676
.6348	−0.704
.6373	−0.683
.6407	−0.709
.6432	−0.666
.6466	−0.678
.6515	−0.645:

b) There is a wellknown method of *Vorontsov-Velyaminov* [16] to distinguish between different parts of the light curve of a nova, plotting magnitudes against log $(t-t_0)$. He stated that the light curve of all but very slow novae can be transformed into straight lines using the logarithm of the number of days which have elapsed since maximum $(t-t_0)$ on the axis of abscissas. It means that light curves of novae are composed from sections, all satisfying the same exponential equation.

$$t = t_0 + 10^{\frac{m-m_i}{b_i}} \qquad i = 1,\ 2,\ 3, \ldots$$

with different m_i and b_i values. Though the maximum of Nova Her 1963 was not observed, several authors agree in its datum as January 27, 1963. Transforming the light curves by *Vorontsov-Velyaminov*'s method we obtained points on a curved, instead of a straight line for the first part of each of the light curves. In order to express the equation of each part of the light curves in the form given above, we tried to determine an optimum set of parameters (t_0, b, m_0) from three points selected arbitrarily on the first part of each of the light curves $\left(m_1, t_1;\ m_2, t_2;\ m_3 = \frac{1}{2}\ (m_1 + m_2),\ t_3\right)$:

$$t_0 = \frac{t_1 t_2 - t_3^2}{t_1 + t_2 - 2t_3}$$

From that point on, where the observed curve bent from the calculated one, we repeated the procedure and similarly deduced a new set of parameters. Resulting t_0 values are somewhat surprising:

t_0 (J.D.24380 . . .)

	part 1	part 2	part 3
y	36	01	95
b	26	26	26
u	26	26	26

After we have found that $t_0 = 2438026$ gave an entirely satisfactory solution in all three colours, we used it as a common zero point, in spite of the fact, that it was definitely earlier than any possible moment for the maximum. It is essential only that its use permits us to transform the light curves into a series of straight lines, not only in the case of the Budapest observations, but for all other photoelectric material. As has been stated already, light curves of different authors coincide in the first part, and that of Hungarian and Chinese observations in the second part of all light curves. This suggestion manifests itself clearly in Fig. 9 where observed Δu, Δb, Δy values are plotted against log $(t-2438026)$. In the second part of the diagram, after the first break, there is a definite divergency between the corresponding sections of the logarithmic light curves of different authors, at least, in one colour. For the sake

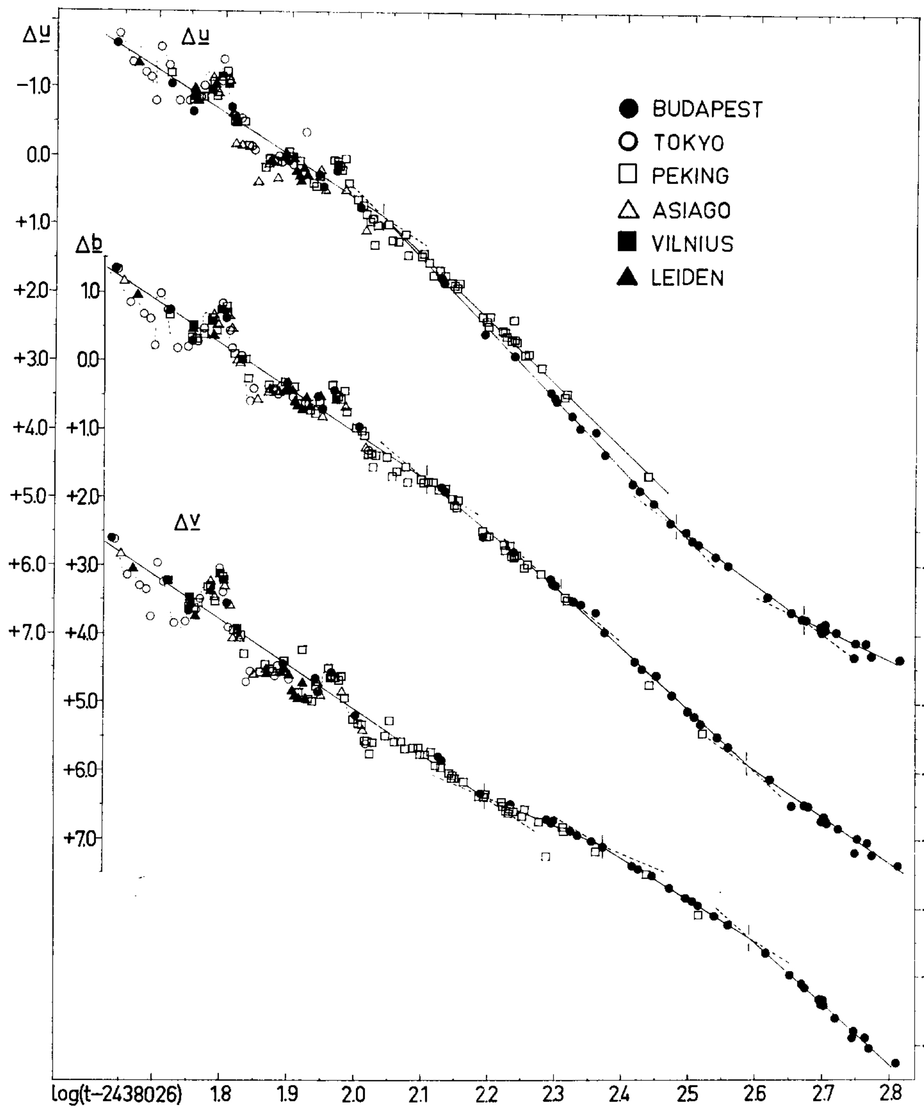


Fig 9. Magnitude differences between Nova Her 1963 and BD + 42°3035 versus logarithm of time interval $t-t_0$, where $t_0=2438026$.

of clarity after 20 Apr. 1963 all observations of Vilnius, Tokyo, Leiden and Asiago were omitted. The slope of all straight lines (b_1, b_2, ...), however, are given in Table VII.

Dates of changes in the slope of the broken lines in Fig. 9 are listed in Table VIII.

Table VII

<table>
<tr><th rowspan="2"></th><th colspan="4">y</th><th colspan="4">b</th><th colspan="4">u</th></tr>
<tr><th>b_1</th><th>b_2</th><th>b_3</th><th>b_4</th><th>b_1</th><th>b_2</th><th>b_3</th><th>b_4</th><th>b_1</th><th>b_2</th><th>b_3</th><th>b_4</th></tr>
<tr><td>Budapest</td><td rowspan="4">6.64</td><td rowspan="2">4.11</td><td rowspan="2">6.06</td><td>8.86</td><td rowspan="4">6.56</td><td rowspan="2">8.14</td><td>9.06</td><td>6.76</td><td rowspan="4">6.41</td><td>10.24</td><td>6.75</td><td>4.52</td></tr>
<tr><td>Peking</td><td>—</td><td>—</td><td>—</td><td>9.43</td><td>—</td><td>—</td></tr>
<tr><td>Tokyo</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Asiago</td><td>9.57</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>10.44</td><td>—</td><td>—</td></tr>
<tr><td>Leiden</td><td>—</td><td>6.76</td><td>—</td><td>—</td><td>7.10</td><td>8.70</td><td>—</td><td>—</td><td>—</td><td>9.36</td><td>—</td><td>—</td></tr>
</table>

Table VIII

	$\log(t-t_0)$	t
u	2.037	2438135
	2.475	325
	2.660	483
b	2.105	2438153
	2.305	228
	2.580	406
y	2.193	2438182
	2.371	261
	2.587	413

It is worth while noting that three observational materials (Budapest, Leiden, Peking) afford the opportunity of determining independently the time of the first break (t_c) and the subsequent changes in the rate of decline. The same method applied to photographic observations by *Busch* [5] and *Hang-Heng-rong* etc. [9] yielded somewhat different results.

The "combined logarithmic light curves" also give proof of the statement in [14] that t_c values increase with effective wave length. Later there is no such simple relation.

From logarithmic light curves it is easy to deduce the brightness and colour of the nova at its maximum by simple extrapolation. Supposing that the maximum occured on January 27 and using our UBV $= u\,b\,y$ values for BD $+42°3035$ we obtain

$$y_{\max} = +3.18$$

$$(b-y)_{\max} = -0.04$$

$$(u-b)_{\max} = -0.79$$

or from the colour curves on Fig. 4

$$(b-y)_{\max} = -0.07$$

$$(u-b)_{\max} = -0.82$$

that is to say in the three colours respectively

$$y_{\max} = 3.18$$
$$b_{\max} = 3.11$$
$$u_{\max} = 2.29$$

According to *Schmidt* [17] the distance and the absolute magnitude of novae can be derived by means of the time needed for the first drop of 3 magnitudes in visual brightness (t_{3y}). Thus

$$M_{pg} = -11.5 + 2.5 \log t_{3y} = -7.13$$

yielding 1100 pc as a distance of Nova Her 1963. It is in the order of magnitude given by *Genderen* [12] and *Chincarini* [10].

There are, however, several thorough spectroscopic observations and investigations on Nova Her 1963 [18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29]. If we compare the evolution of the spectrum with that of the brightness in different colours the coincidence around April — May 1963 is apparent. The end of the "early decline" period at about 1 April, marked by the disappearance of absorption lines, by changes in the continuum and by sudden variation in the radial velocity derived from Orion type lines [18] is accompanied by the largest sudden decrease in brightness and by the prominent break in the $b-y$ curve. During the short transition stage the rate of decline changes in all colours, one after the other. The beginning of the nebular stage (about May 1), transforming the appearance of the whole spectrum, is marked on the light curves by the vanishing of fluctuations. The continuous evolution of the spectrum in the nebular stage is parallelled by the relative stability of the form of the light and colour-index curves. It would be undoubtedly interesting to compare in details spectral and photometric variations of novae during later stages of their evolution.

We should like to express our indebtedness to Prof. L. Rosino, Director of the Asiago Astrophysical Observatory, for having allowed us to use their photoelectric equipment; it is a pleasure to thank Dr. G. Chincarini for unpublished data and helping in the observations at Asiago; finally the help of Mr's L. Fodor, K. Gefferth, A. Gesztesi and K. Thaly in the observations and the reduction are gratefully acknowledged.

Budapest, July 1966

REFERENCES

1. R. H. Hardie: Photoelectric Reductions, in Astronomical Techniques (University of Chicago Press 1962)
2. E. Dahlgren: BAV Rundbrief **12,** 3, 1963.
3. W. Quester: BAV Rundbrief **12,** 3, 1963.
4. R. Weber: Bul. de la Station Astrophotographique de Mainteine **2,** 5. **1,** 1, 1964.
5. H. Busch: MVS **2,** 4, 1964.
6. D. B. Mc Laughlin: Sky and Tel. **25,** 4, 1963.
7. P. Ahnert: MVS **2,** 3, 1964.
8. K. Löchel: MVS **2,** 1, 1963.

9. Hang-Heng-rong and Yao Bao-an: Acta Astr. Sinica **12,** 1, 1964.
10. G. Chincarini: Coelum **31,** 5—6—7—10, 1963. Publ. ASP **76,** 289, 1964.
11. К. Зданавичюс and Р. Калитис: Vilnius Biuletenis No. 10, 1964.
12. A. M. van Genderen: BAN **17,** 4, 1964.
13. M. Huruhata: Tokyo Astr. Bull. 164, 1964.
14. Shen Liang-zhao etc.: Acta Astr. Sinica **12,** 2, 1964.
15. J. B. Breckinridge: Publ. ASP **76,** 449, 1964.
16. B. A. Woronzow—Weljaminow: Gasnebel und Neue Sterne (Verlag Kultur und Fortschritt) 286 1953.
17. Th. Schmidt: Zs. f. Ap. **41,** 182, 1957.
18. A. H. Batten: J. RAS Canada **58,** 6, 1964.
19. A. J. **68,** 8, 1963.
20. W. C. Seitter: Bonn Veröff. 67, 1963.
21. C. B. Stephenson and R. B. Herr: Publ. ASP **75,** 444, 1963.
22. Н. Л. Иванова, М. А. Казарян and Р. Х. Оганесян: А. Ц. 239, 1963.
23. M. Bloch and D. Chalonge: Ann. d'Astrophys. **27,** 4, 1964.
24. D. Chalonge, M. Bloch, L. Divan and A. M. Fringant: Publ. Obs. Haute Provence **7,** 27, 1964.
25. Y. Andrillat: Ann. d'Astrophys. **27,** 5, 1964.
26. L. F. Ahlmark and K. A. Clement: Ark. Astr. **3,** 26, 1964.
27. G. Chincarini: Mem. SA It. **35,** 2, 1964.
28. G. Chincarini and L. Rosino: Ann. d'Astrophys. **27,** 5, 1964.
29. R. Glebocki, J. Smolinski and A. Woszczyk: AA **14,** 4, 1964.
30. G. Chincarini: Private communication.
31. L. Rosino: IAU Circular No. 1953 1966.
32. G. Chincarini and S. Howard: IBVS No. 139 1966

ERRATA

In Mitteilungen der Sternwarte der Ungarischen Akademie der Wissenschaften Nr. **59** p. 9 last two equations read

$$(\mu_n - \mu_0)' = \frac{k\,\varkappa^2}{R_n^2}(\mu_n - \mu_0)$$

$$\sin i' = \frac{\sqrt{\sin^2\varphi_0 - 2\sin\varphi_0\sin\varphi_n\cos(\mu_n - \mu_0)' + \sin^2\varphi_n}}{\sin(\mu_n - \mu_0)'}$$

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KÖZLEMÉNYEI

MITTEILUNGEN
DER
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DER WISSENSCHAFTEN

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Nr. 61

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PHOTOELECTRIC OBSERVATIONS OF VARIABLE STARS

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INTRODUCTION

Twenty-eight variable and suspected variable stars were chosen for observation (see Table No. 1) from the "General Catalogue of Variable Stars". An attempt was made to choose stars of questionable classification and also to include some semi-regular and irregular variables which had not been well observed. The stars were also chosen for favorable positions in the sky for the observing period involved.

EQUIPMENT

All observations were made with the Lowell Observatory 21-inch reflector and other photoelectric equipment used for the Solar Variation Program. This equipment includes a photometer with a 1P21, standard B and V filters, a GR 1230 DC amplifier, and a Brown recorder.

OBSERVATIONS

The 1P21 was cooled with dry ice at least two hours prior to the beginning of observations, and dry ice was added each two hours thereafter during the night. Every six or eight weeks the amplifier was calibrated in half and two and a half magnitude steps (Serkowski, 1961). The deflections were recorded on a Brown recorder strip-chart potentiometer in the sequence B, sky B, V, sky V; these were followed by observations of a radioactive source and the dark current.

Many primary and secondary UBV standard stars were observed at various air masses throughout the night (Johnson and Harris, 1954) in order to determine the extinction and color corrections. No observations were made within three days of full moon and no observations were attempted if clouds were suspected.

REDUCTIONS

The reductions were made by means of the formulae and least-squares method described by Serkowski (1961).

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LIGHT CURVES

Drawings showing B, V, and B—V data are given (Figures 1—17) for 17 of the 28 stars observed. Only the most interesting data are shown. The B observations are shown by filled circles, the V observations by the open circles, and the B—V color points below.

DESCRIPTION OF TABLE AND FIGURES

Table No. 1 lists all stars observed. The first four columns list the star names, the type of variable, the period and the spectral types as given in the "General Catalogue of Variable Stars" (second edition). The fifth and sixth columns list the observed B—V values at maximum and minimum light.

Figure 18 is a B—V vs. spectral type diagram for the 28 stars. The long dashed line represents the main-sequence and the small dashed line below the yellow giants according to Johnson and Morgan (1953). Most of the variables plotted appear to lie close to the giant sequence if one assumes that the giant branch crosses the main-sequence at approximately B—V = = +1.6.

Figure 19 is the observed color B—V amplitude vs. the visual V magnitude amplitude. This indicates that a large amplitude in brightness necessitates a large color change for this group of stars.

Figure 20 shows the relation between the log of the period and color at minimum light, after Kron and Svolopoulas (1959) and transformed to the B, V system. The small filled circles to the left indicate 25 galactic cepheid variables observed at minimum light by Eggen, Gascoigne, and Burr (1957) and transformed here to B—V. The open circles to the right show the 12 semiregular variables observed at minimum light by Smak (1964). The large filled circles to the right are observations from this paper where a period could be found.

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TABLE NO. 1

Name	From "General Catalogue of Variable Stars" Second Edition			Present observations B—V at	
	type	period	spect.	maximum light	minimum light
W BOO	?		M3	1.70	—
Y BOO	cst ?		KO III	1.05	—
RX BOO	SRb	(210±)	M7e—8e	1.76	1.79
RY BOO	cst ?		F6—IV	.44	—
UV BOO	Ia		F5	.41	—
X CNC	SRb	170±	N3($C5_4$)	3.39	3.24
RS CNC	SRc ?	120	M6	1.70	1.66
RT CNC	SRb	90	M5 III	1.56	1.46
V CVN	SRa	191.88	M4e—M6e	1.51	1.60
TU CVN	Ib	(50±)	M6	1.62	1.58
TW COM	Ib		K5	1.51	1.42
VW GEM	Ib		N($C3_9$)	2.44	2.48
BN GEM	Ia ?		08V : pe	—.12	—
BQ GEM	?	(50±)	M4	1.64	1.61
VV LEO	SR	181.5	M7	1.82	1.84
WX LEO	Ib		M5	1.54	1.46
AI LEO	Ib		M5	1.79	1.66
AK LEO	Ib	(60±)	M5	1.49	1.52
SV LYN	SR ?	(70±)	gM5	1.56	1.61
ST UMA	SRb	81	M4 III	1.67	1.63
TV UMA	SRb	50.38	M5 III	1.54	1.52
SW VIR	SRb	150±	M7	1.80	1.76
BG VIR	I ?	(50±)	M5	1.50	1.48
BK VIR	Ib	(150±)	M7	1.62	1.63
CN VIR	Ib	(60±)	M3	1.68	1.63
CO VIR	Ib	(70±)	M5	1.57	1.55
CP VIR	?1		M7	1.55	1.46
CQ VIR	Ib		M3	1.71	1.60

Those periods given in parentheses () above are estimated from the observations here.

NOTES TO TABLE 1.

W BOO: Listed as? Observations here still leave doubt as to variability.

Y BOO: Listed as cst? Observations here indicate it is probably not variable.

RX BOO: Listed as SRb. Light curves appear to confirm this classification. Period $210^d\pm$. See Fig. 1.

RY BOO: Listed as cst? Eighteen observations here indicate it probably is not variable.

UV BOO: Listed as Ia. Sixteen observations here indicate it is probably not variable.

X CNC: Listed as SRb: Light curves appear to confirm this classification. See Fig. 2.

RS CNC: Appears to be as listed (SRc), but with a 160 ($\pm$) day period. See Fig. 3.

RT CNC: Appears to be as listed (SRb), with a period for these observations of 140^d. Note how the B—V changed (bluer) as the star passed through minimum light. See Fig. 4.

V CVN: Listed as SRa with period of 191.88^d. These observations confirm the above. See Fig. 5.

TU CVN: Listed as Ib. Light curve here appears to suggest SRb with period of $50^d\pm$. See Fig. 6.

TW COM: Listed as Ib. Too few observations here.

VW GEM: Too few observations here.

BN GEM: Listed as Ia? Twenty-two observations here indicate it probably not variable.

BQ GEM: Type listed as? The light curves here indicate an SRb type with a period of 50 days ($\pm$). See Fig. 7.

VV LEO: Too few observations here.

WX LEO: Too few observations here.

AI LEO: Listed as Ib, light curves here indicate an SRb type with too few observations to determine a period. See Fig. 8.

AK LEO: Listed as Ib, light curve here suggests it may be SRb with period of $60^d\pm$. See Fig. 9.

SV LYN: Listed as SR? Observations here indicate type SRb with a period of 70 days ($\pm$). See Fig. 10.

ST UMA: Type listed as SRb with a period of 81 days. Observations here confirm the type, but the period appears to be longer ($\sim$90d). See Fig. 11.

TV UMA: Listed as SRb with period of 50.38 days, observations here confirm the type but the average period ($\sim$42d) appears to be shorter. See Fig. 12.

SW VIR: Type listed as SRb with period of 150 days ($\pm$). Too few observations here to confirm. See Fig. 13.

G VIR: Listed as type I? Observations here indicate this star may be type SRb with a period of 50 days($\pm$). See Fig. 14.

BK VIR: Listed as type Ib. Observations here indicate an SRb star with a period of $150^d\pm$. See Fig. 15.

CN VIR: Type listed is Ib. Observations here suggest an SRb star with a period of $60^d\pm$. See Fig. 16.

CO VIR: Listed as type Ib. Too few observations to confirm this classification.

CP VIR: Listed as type ?I. Observations here indicate an SRb type with a period of $\sim$70 days. See Fig. 17.

CQ VIR: Type listed as Ib. Observation here suggest an SRb star with too few observations to determine a period.

STAR REFERENCES

W BOO — E. Mendoza, Tonantzintla Bol. 28, 4, 1967
AAVSO Quarterly Reports
P. Ahnert, MVS No 109, 1947

Y BOO — AAVSO Quarterly Reports

RY BOO — Kuibyshev Astro. Obs. VS Bull 14, 1962
AAVSO Quarterly Reports

RX BOO — AAVSO Quarterly Reports

UV BOO — AAVSO Quarterly Reports
P. Ahnert, MVS, 109, 1947

X CNC — E. Mendoza, Tonantzintla Bol. 28, 4, 1967
AAVSO Quarterly Reports
LANDOLT, A. U., P. A. S. P., 78, 531.

RS CNC — AAVSO Quarterly Reports
Japan. Astr. Study Assoc. Circ. 182—3, 1958

RT CNC — AAVSO Quarterly Reports

V CVN — Rep. No. 4 Groningen, Kapteyn Astro. Lab. 1963
AAVSO Quarterly Reports
LANDOLT, A. U., 1966, P. A. S. P., 78, 531.

TU CVN — AAVSO Quarterly Reports

TW COM — M. Beyer, Erg. AN 12, 2, 1950

VW GEM — AAVSO Quarterly Reports
M. Beyer, AN 263, 33, 1937

BN GEM — Kuibyshev Astro. Obs. VS Bull 14, 1962
AAVSO Quarterly Reports
C. Hoffmeister, AN 253, 195, 1934

BQ GEM — Kuibyshev Astron. Obs. VS Bull 14, 1962
AAVSO Quarterly Reports
J. Stebbins, C. M. Huffer, Washb. Publ. 15, 3, 1928

VV LEO — M. Esch, AN 264, 64, 1937

WX LEO — S. Bőhme, AN 266, 169, 1938

AI LEO — M. Beyer, Erg AN 12, 2, 1950

AK LEO — M. Beyer, Erg AN 12, 2, 1950

SV LYN — A. B. Conosbee, AII, 159, 1955

ST UMA — Groningen Nr. 5, 6, Kapteyn Astro. Lab. 1964
AAVSO Quarterly Reports
E. Loreta, AN 267, 397, 1939
LANDOLT, A. U., 1966, P. A. S. P., 78, 531.

TV UMA — AAVSO Quarterly Reports
C. Payne-Gaposchkin, HA 118, 13, 1952
SW VIR — AAVSO Quarterly Reports
C. Payne-Gaposchkin, HA 115, 26, 1950
BG VIR — C. Hoffmeister, AN 255, 401, 1935
BK VIR — AAVSO Quarterly Reports
M. Beyer, Erg AN 12, 2, 1950
CN VIR — AAVSO Quarterly Reports
M. Beyer, Erg AN 12, 2, 1950
CO VIR — AAVSO. Quarterly Reports
M. Beyer, Erg AN 12, 2, 1950
CP VIR — H. Sandig, AN 276, 173, 1948
CQ VIR — M. Beyer, Erg AN 12, 2, 1950

OBSERVATIONS

W BOO

J. D.	Date 1963	B	V
2,438,051	Jan. 21	6.44	4.77
053	23	6.45	4.76
055	25	6.46	4.79
064	Feb. 3	6.49	4.82
067	6	6.44	4.77
082	21	6.45	4.79
096	Mar. 7	6.43	4.73
109	20	6.43	4.74
124	Apr. 4	6.46	4.78
163	May 13	6.43	4.77
186	June 5	6.45	4.79

Y BOO

J. D.	Date 1963	B	V
2,438,055	Jan. 25	8.98	7.95
058	28	8.98	7.95
064	Feb. 3	8.98	7.95
067	6	8.98	7.95
082	21	8.96	7.94
085	24	8.98	7.95
096	Mar. 7	8.97	7.93
109	20	8.98	7.94
124	Apr. 4	8.99	7.95
162	May 12	8.98	7.96
166	16	8.98	7.96

RX BOO

J. D.	Date 1963	B	V
2,438,053	Jan. 23	9.53	7.72
055	25	9.54	7.76
058	28	9.51	7.75
064	Feb. 3	9.55	7.76
067	6	9.50	7.72
082	21	9.40	7.64
096	Mar. 7	9.34	7.57
109	20	9.29	7.53
124	Apr. 4	9.32	7.59
149	29	9.58	7.84
162	May 12	9.74	8.00
166	16	9.79	8.02
171	21	9.83	8.06
174	24	9.86	8.06
179	29	9.89	8.11
186	June 5	9.91	8.12
191	10	9.91	8.11
194	13	9.88	8.12

RY BOO

J.D.	Date 1962		V
2,438,021	Dec. 22	7.56	7.12
029	30	7.56	7.12
	1963		
037	Jan. 7	7.55	7.12
039	9	7.56	7.12
045	15	7.56	7.13
047	17	7.56	7.12
051	21	7.59	7.15
053	23	7.56	7.12
064	Feb. 3	7.60	7.16
067	6	7.56	7.12
082	21	7.56	7.12
085	24	7.56	7.13
096	Mar. 7	7.56	7.12
109	20	7.58	7.15
124	Apr. 4	7.60	7.15
153	May 3	7.56	7.12
162	12	7.58	7.14
166	16	7.56	7.13

UV BOO

J. D.	Date 1963		B	V
2,438,045	Jan.	15	8.55	8.14
047		17	8.55	8.14
051		21	8.55	8.14
053		23	8.55	8.13
055		25	8.54	8.14
058		28	8.55	8.14
064	Feb.	3	8.56	8.15
067		6	8.55	8.13
082		21	8.54	8.12
096	Mar.	7	8.56	8.14
109		20	8.56	8.16
124	Apr.	4	8.58	8.14
149		29	8.55	8.14
162	May	12	8.55	8.14
166		16	8.55	8.14
179		29	8.54	8.11

X CNC

J. D.	Date 1962		B	V
2,437.970	Nov.	1	10.14	6.80
971		2	10.15	6.91
972		3	10.17	6.89
974		5	10.20	6.96
977		8	10.19	6.95
980		11	10.21	6.98
992		23	10.23	6.98
996		27	10.26	7.02
2,438,003	Dec.	4	10.24	7.00
005		6	10.24	6.99
007		8	10.23	7.00
021		22	10.16	6.88
029		30	10.10	6.82
	1963			
039	Jan.	9	10.05	6.55
045		15	9.94	6.42
047		17	9.89	6.44
051		21	9.87	6.42
053		23	9.83	6.37
058		28	9.79	6.35

X CNC (cont)

J. D.	Date 1962	B	V
2,438,064	Feb. 3	9.72	6.30
067	6	9.70	6.28
077	16	9.65	6.26
082	21	9.66	6.27
104	Mar. 15	9.78	6.31
132	Apr. 12	9.80	6.41
145	25	9.77	6.39
153	May 3	9.68	6.39
163	13	9.62	6.34

RS CNC

J. D.	Date 1962	B	V
2,437,970	Nov. 1	7.27	
971	2	7.27	5.67
972	3	7.28	5.66
974	5	7.30	5.67
977	8	7.31	5.67
979	10	7.31	5.70
980	11	7.35	5.71
996	27	7.42	5.78
2,438,003	Dec. 4	7.48	5.86
005	6	7.50	5.85
007	8	7.49	5.85
020	21	7.63	5.99
021	22	7.64	6.00
029	30	7.68	6.04
	1963		
039	Jan. 9	7.71	6.05
045	15	7.68	6.03
047	17	7.60	5.99
051	21	7.57	5.95
053	23	7.53	5.89
055	25	7.48	5.86
064	Feb. 3	7.30	5.68
067	6	7.25	5.64
077	16	7.09	5.47
080	19	7.08	5.44
082	21	7.01	5.40
086	25	6.93	5.30
104	Mar. 15	6.77	5.1

RS CNC (cont.)

J. D.	Date 1963	B	V
2,438,109	Mar. 20	6.76	5.06
132	Apr. 12	7.17	5.50
143	23	7.35	5.68
145	25	7.38	5.70
149	29	7.45	5.74
153	May 3	7.48	5.82
162	12	7.55	5.91
163	13	7.57	5.89
166	16	7.60	5.91
179	29	7.72	6.03

RT CNC

J. D.	Date 1962	B	V
2,437,974	Nov. 5	9.09	7.57
977	8	9.10	7.58
979	10	9.11	
980	11	9.12	7.59
992	23	9.13	7.59
996	27	9.06	7.54
2,438,003	Dec. 4	9.04	7.50
005	6	9.00	7.44
007	8	8.99	7.44
021	22	9.06	7.48
029	30	9.13	7.55
	1963		
039	Jan. 9	9.18	7.61
045	15	9.21	7.70
047	17	9.20	7.72
051	21	9.26	7.78
052	23	9.30	7.80
055	25	9.33	7.83
064	Feb. 3	9.37	7.90
067	6	9.36	7.90
077	16	9.27	7.80
082	21	9.17	7.71
086	25	9.10	7.63
104	Mar. 15	9.11	7.58
132	Apr. 12	8.97	7.41
143	23	8.93	7.36
145	25	8.93	7.36
153	May 3	8.92	7.36
163	13	8.95	7.38
166	16	8.97	7.39

V CVN

J. D.	Date 1962	B	V
2,438,005	Dec. 6	8.86	7.20
021	22	9.05	7.39
029	30	9.26	7.58
	1963		
037	Jan. 7	9.57	7.92
039	9	9.65	8.02
045	15	9.82	8.16
047	17	9.83	8.19
051	21	9.89	8.24
053	23	9.90	8.25
055	25	9.90	8.27
058	28	9.88	8.28
064	Febr. 3	9.81	8.21
067	6	9.79	8.18
082	21	9.81	8.20
124	Apr. 4	8.90	7.41
145	25	8.54	7.03
162	May 12	8.66	7.19
166	16	8.65	7.18
179	29	8.68	7.21
186	June 5	8.79	7.31

TU CVN

J. D.	Date 1962	B	V
2,438,005	Dec. 6	7.33	5.75
020	21	7.33	5.77
029	30	7.25	5.68
	1963		
037	Jan. 7	7.28	5.70
039	9	7.27	5.69
045	15	7.34	5.75
047	17	7.32	5.74
051	21	7.33	5.74
053	23	7.31	5.71
055	25	7.30	5.71
058	28	7.27	5.69
064	Feb. 3	7.27	5.68
067	6	7.26	5.67
082	21	7.37	5.78
096	Mar. 7	7.36	5.75

TU CVN (cont)

J. D.	Date 1963		B	V
2,438,104	Mar.	15	7.17	5.57
109		20	7.17	5.55
124	Apr.	4	7.37	5.78
132		12	7.41	5.83
143		23	7.30	5.73
149		29	7.29	5.70
151	May	1	7.28	5.70
153		3	7.28	5.70
162		12	7.29	5.71
163		13	7.28	5.69
166		16	7.26	5.67
174		24	7.24	5.65
179		29	7.26	5.69
186	June	5	7.34	5.76
194		13	7.32	5.76

TW COM

J. D.	Date 1963		B	V
2,438,051	Jan.	21	11.25	9.77
053		23	11.24	9.82
055		25	11.28	9.82
058		28	11.26	9.78
064	Feb.	3	11.18	9.69
124	Apr.	4	10.95	9.44
143		23	11.33	9.90
162	May	12	11.10	9.64

VW GEM

J. D.	Date 1962		B	V
2,437,979	Nov.	10	11.00	8.52
2,438,007	Dec.	8	10.88	8.42
021		22	10.82	8.39
	1963			
047	Jan.	17	10.74	8.32
053		23	10.72	8.27
064	Feb.	3	10.75	8.33
077		16	10.76	8.35
082		21	10.81	8.39

BN GEM

J. D.	Date 1962	B	V
2,437,970	Nov. 1	6.63	—
971	2	6.64	6.78
972	3	6.63	6.79
974	5	6.64	6.81
977	8	6.63	6.79
992	23	6.62	6.78
995	26	6.64	6.76
996	27	6.64	6.77
2,438,003	Dec. 4	6.62	6.77
005	6	6.62	6.75
007	8	6.63	6.76
021	22	6.64	6.77
	1963		
047	Jan. 17	6.64	6.79
051	21	6.65	6.79
053	23	6.64	6.79
064	Febr. 3	6.64	6.79
077	16	6.63	6.77
082	21	6.63	6.76
104	Mar. 15	6.61	6.76
132	Apr. 12	6.63	6.75
145	25	6.61	6.74
153	May 3	6.64	6.76

BQ GEM

J. D.	Date 1962	B	V
2,437,972	Nov. 3	6.80	
977	8	6.81	5.19
979	10	6.83	5.20
980	11	6.84	5.21
992	23	6.93	
995	26	6.93	5.31
996	27	6.94	5.34
2,438,003	Dec. 4	6.94	5.32
005	6	6.92	5.29
007	8	6.92	5.27
021	22	6.77	5.13
	1963		
047	Jan. 17	6.81	5.19
051	21	6.80	5.15
053	23	6.78	5.14

BQ GEM (cont)

J. D.	Date 1963	B	V
2,438,064	Feb. 3	6.72	5.07
077	16	6.63	4.98
080	19	6.73	5.04
082	21	6.68	5.04
104	Mar. 15	6.93	5.27
132	Apr. 12	6.72	5.05
145	25	6.90	5.23
153	May 3	7.01	5.33

VV LEO

J. D.	Date 1962	B	V
2,438,021	Dec. 22	11.78	10.07
	1963		
047	Jan. 17	11.73	10.00
051	21	11.79	9.97
053	23	11.80	9.98
058	28	11.85	10.01
082	Feb. 21	12.05	10.21

WX LEO

J. D.	Date 1963	B	V
2,438,051	Jan. 21	9.89	8.39
053	23	9.93	8.44
055	25	9.97	8.48
058	28	9.99	8.46
064	Febr. 3	9.96	8.50
067	6	9.95	8.48
124	Apr. 4	9.56	8.05
163	May 13	9.59	8.06
166	16	9.57	8.04
186	June 5	9.48	7.94

AI LEO

J. D.	Date 1963	B	V
2,438,047	Jan. 17	10.23	8.44
051	21	10.26	8.50
053	23	10.29	8.50
055	25	10.32	8.54
058	28	10.36	8.59
082	Feb. 21	10.66	8.93
109	Mar. 20	11.85	9.13
143	Apr. 23	11.09	9.38
162	May. 12	11.11	9.45
163	13	11.13	9.44
166	16	11.13	9.42
174	24	11.02	9.31
179	29	10.88	9.18
194	June 13	10.43	8.69

AK LEO

J. D.	Date 1962	B	V
2,438,003	Dec. 4	10.25	8.72
005	6	10.24	8.68
007	8	10.25	8.68
009	10	10.21	8.71
020	21	10.19	8.70
021	22	10.19	8.66
029	30	10.23	8.75
	1963		
037	Jan. 7	10.26	8.77
039	9	10.26	8.78
045	15	10.28	8.78
047	17	10.28	8.78
051	21	10.33	8.81
053	23	10.35	8.82
055	25	10.36	8.83
058	28	10.38	8.85
064	Feb. 3	10.39	8.87
067	6	10.38	8.89
082	21	10.38	8.88
109	Mar. 20	10.15	8.67
124	Apr. 4	10.53	9.00
132	12	10.25	8.71
143	23	10.29	8.77
145	25	10.27	8.74

AK LEO (cont.)

J. D.	Date 1963	B	V
2,438,149	Apr. 29	10.22	8.69
151	May 1	9.85	8.36
162	12	10.03	8.54
163	13	10.09	8.54
166	16	10.09	8.54
174	24	10.13	8.59
179	29	10.12	8.62
186	June 5	10.06	8.54
194	13	10.01	8.49

SV LYN

J. D.	Date 1962	B	V
2,437,972	Nov. 3	8.40	6.84
977	8	8.42	6.84
979	10	8.42	—
992	23	8.55	6.97
996	27	8.59	7.00
2,438,003	Dec. 4	8.60	7.06
005	6	8.59	7.01
007	8	8.59	—
021	22	8.67	7.09
	1963		
051	Jan. 21	8.51	6.89
053	23	8.51	6.89
058	28	8.42	6.85
064	Feb. 3	8.63	7.03
067	6	8.66	7.07
077	16	8.84	7.24
082	21	8.83	7.26
104	Mar. 15	8.55	6.92
132	Apr. 12	8.50	6.90
145	25	8.65	7.06
153	May 3	8.63	7.03
162	12	8.58	7.00
163	13	8.59	6.96
166	16	8.60	6.94

ST UMA

J. D.	Date 1962	B	V
2,438,003	Dec. 4	8.55	6.92
005	6		6.89
009	10	8.42	6.82
020	21	8.20	6.57
021	22	8.18	6.51
209	30	8.15	6.48
	1963		
037	Jan. 7	8.18	6.50
039	9	8.18	6.53
045	15	8.21	6.57
047	17	8.22	6.59
051	21	8.30	6.65
053	23	8.32	6.67
055	25	8.37	6.74
058	28	8.42	6.77
064	Feb. 3	8.50	6.89
067	6	8.55	6.94
082	21	8.60	6.97
086	25	8.56	6.94
087	26	8.55	6.94
096	Mar. 7	8.44	6.81
104	15	8.34	6.70
109	20	8.28	6.63
123	Apr. 3	8.24	6.58
124	4	8.22	6.56
132	12	8.18	6.54
143	23	8.23	6.59
145	25	8.23	6.58
149	29	8.24	6.59
151	May 1	8.25	6.60
153	3	8.25	6.61
160	10	8.23	6.60
162	12	8.21	6.61
163	13	8.24	6.61
166	16	8.22	6.58
174	24	8.21	6.53
179	29	8.15	6.55
186	June 5	8.22	6.56
194	13	8.19	6.54

TV UMA

J. D.	Date 1962		B	V
2,438,003	Dec.	4	8.66	7.13
005		6	8.61	7.06
009		10	8.54	7.03
020		21	8.70	7.20
021		22	8.71	7.18
029		20	8.81	7.28
	1963			
037	Jan.	7	8.75	7.24
039		9	8.73	7.22
045		15	8.74	7.22
047		17	8.73	7.21
051		21	8.78	7.26
053		23	8.78	7.25
		25	8.79	7.27
058		28	8 79	7.28
064	Feb.	3	8.81	7.29
067		6	8.80	7.29
082		21	8.59	7.04
086		25	8.59	7.04
087		26	8.58	7.03
096	Mar.	7	8.64	7.11
104		15	8.67	7.15
109		20	8.65	7.13
124	Apr.	4	8.41	6.85
132		12	8.49	6.95
143		23	8.64	7.14
145		25	8.66	7.14
149		29	8.70	7.18
151	May	1	8.73	7.22
153		3	8.74	7.24
160		10	8.72	7.22
162		12	8.70	7.19
163		13	8.69	7.16
166		16	8.63	7.11
174		24	8.48	6.93
179		29	8.36	6.83
186	June	5	8.29	6.75
194		13	8.33	6.78

SW VIR

J. D.	Date 1963	B	V
2,438,051	Jan. 21	8.64	6.90
053	23	8.63	6.88
055	25	8.63	6.89
058	28	8.61	6.88
064	Feb. 3	8.62	6.87
067	6	8.62	6.87
082	21	8.64	6.86
096	Mar. 7	8.59	6.82
109	20	8.61	6.82
124	Apr. 4	8.79	7.02
144	24	8.92	7.17
149	29	8.96	7.19
151	May 1	8.96	7.20
153	3	8.95	7.19
162	12	8.94	7.20
163	13	8.93	7.17
166	16	8.92	7.15
179	29	8.89	7.13
194	June 13	8.90	7.14

BG VIR

J. D.	Date 1963	B	V
2,438,064	Feb. 3	10.58	9.09
082	21	10.68	9.18
085	24	10.67	9.18
096	Mar. 7	10.52	9.01
109	20	10.58	9.04
124	Apr. 4	10.69	9.19
142	22	10.63	9.15
153	May 3	10.57	9.05
162	12	10.44	8.94
166	16	10.50	8.96
171	21	10.60	9.13
174	24	10.67	9.15
179	29	10.64	9.14
186	June 5	10.61	9.11
191	10	10.56	9.04
194	13	10.51	9.02

BK VIR

J. D.	Date 1963	B	V
2,437,047	Jan. 17	9.75	8.12
051	21	9.80	8.15
053	23	9.74	8.10
055	25	9.74	8.14
058	28	9.80	8.18
064	Feb. 3	9.84	8.22
067	6	9.85	8.22
082	21	9.80	8.16
124	Apr. 4	8.92	7.30
132	12	8.89	7.28
143	23	8.90	7.28
149	29	8.96	7.32
151	May 1	8.96	7.34
162	12	9.10	7.51
163	13	9.13	7.50
166	16	9.18	7.55
174	24	9.31	7.65
179	29	9.36	7.74
186	June 5	9.44	7.79
194	13	9.54	7.88

CN VIR

J. D.	Date 1963	B	V
2,438,047	Jan. 17	9.88	8.24
051	21	9.86	8.19
053	23	9.86	8.17
058	28	9.87	8.23
064	Feb. 3	9.98	8.32
067	6	10.02	8.39
082	21	10.13	8.49
124	Apr. 4	10.00	8.38
132	12	10.08	8.49
143	23	10.08	8.47
149	29	10.04	8.42
151	May 1	10.00	8.38
162	12	9.91	8.27
163	13	9.90	8.26
166	16	9.93	8.28
174	24	10.01	8.38
179	29	10.10	8.49
186	June 5	10.24	8.60
194	13	10.25	8.64

CO VIR

J. D.	Date 1963	B	V
2,438,051	Jan. 21	10.56	9.01
053	23	10.57	9.02
055	25	10.58	9.06
058	28	10.61	9.07
064	Feb. 3	10.68	9.14
067	6	10.73	9.18
082	21	10.85	9.30
124	Apr. 4	10.67	9.13
151	May 1	10.66	9.11
162	12	10.57	9.02
163	13	10.55	9.01
166	16	10.51	8.97
179	29	10.35	8.80
186	June 5	10.33	8.76
194	13	10.40	8.83

CP VIR

J. D.	Date 1963	B	V
2,438,051	Jan. 21	10.01	8.48
053	23	9.97	8.42
055	25	9.96	8.41
058	28	9.93	8.38
082	Feb. 21	10.18	8.66
096	Mar. 7	10.25	8.69
109	20	10.18	8.62
124	Apr. 4	10.02	8.45
142	22	10.07	8.53
143	23	10.09	8.53
144	24	10.11	8.56
149	29	10.17	8.63
151	May 1	10.22	8.67
153	3	10.23	8.69
162	12	10.37	8.91
163	13	10.38	8.89
166	16	10.37	8.90
179	29	10.31	8.86
180	June 5	10.16	8.63
194	13	10.09	8.52

CQ VIR

J. D.	Date 1963		B	V
2,438,051	Jan.	21	10.76	9.06
053		23	10.74	9.03
055		25	10.75	9.05
064	Feb.	3	10.71	8.99
124	Apr.	4	11.02	9.35
162	May	12	11.24	9.64
166		16	11.25	9.64
174		24	11.22	9.59
179		29	11.23	9.64
186	June	5	11.21	9.57
194		13	11.09	9.51

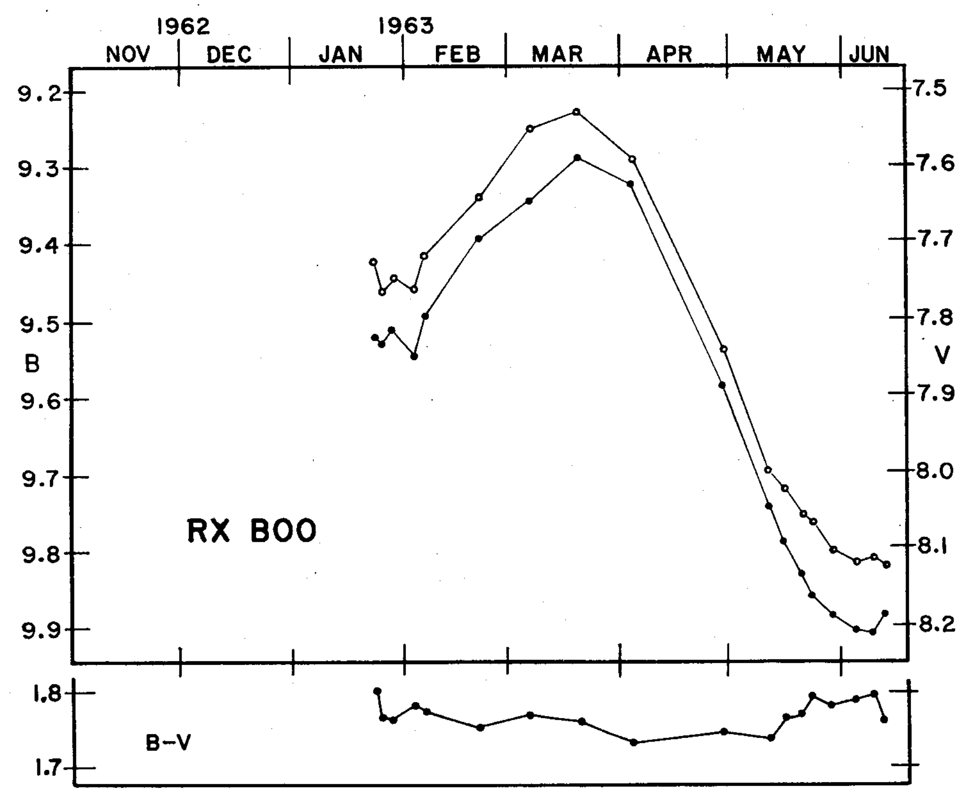

Fig. 1

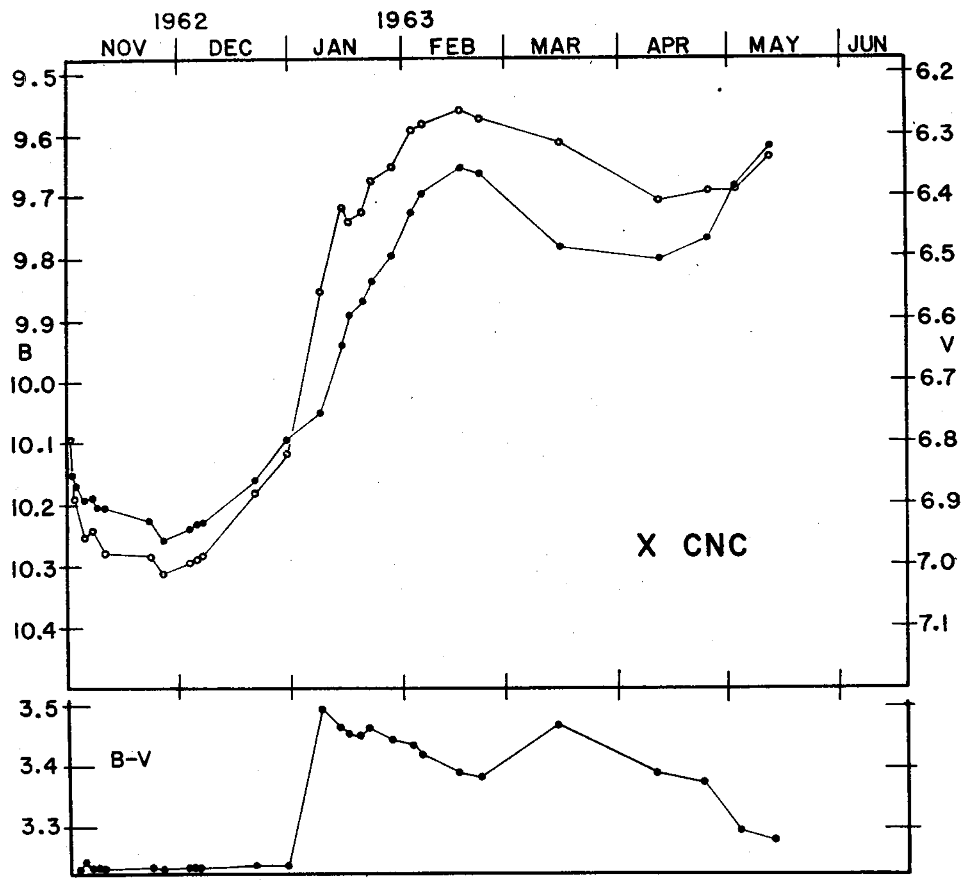

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Fig. 2

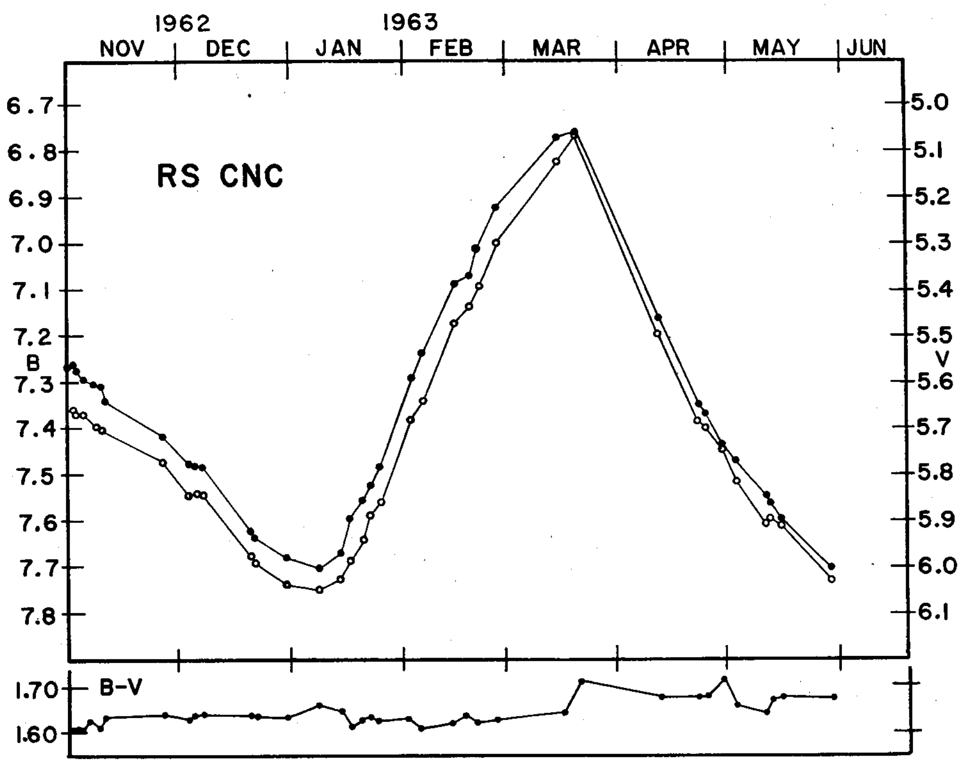
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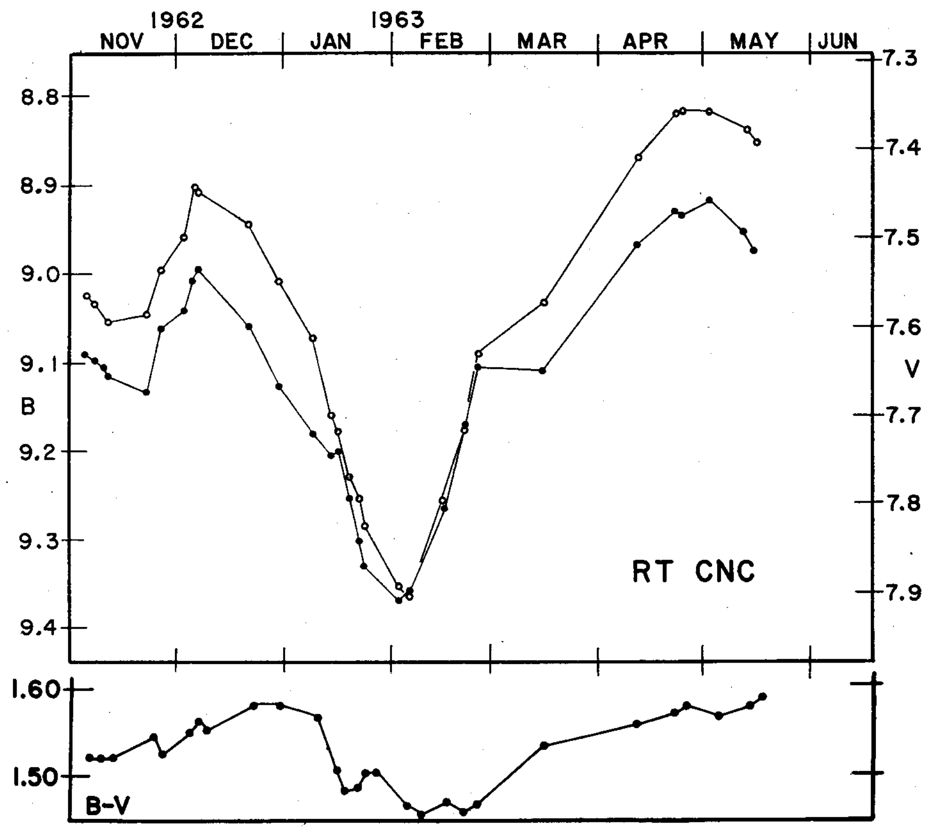
Fig. 3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B-V

Fig. 4

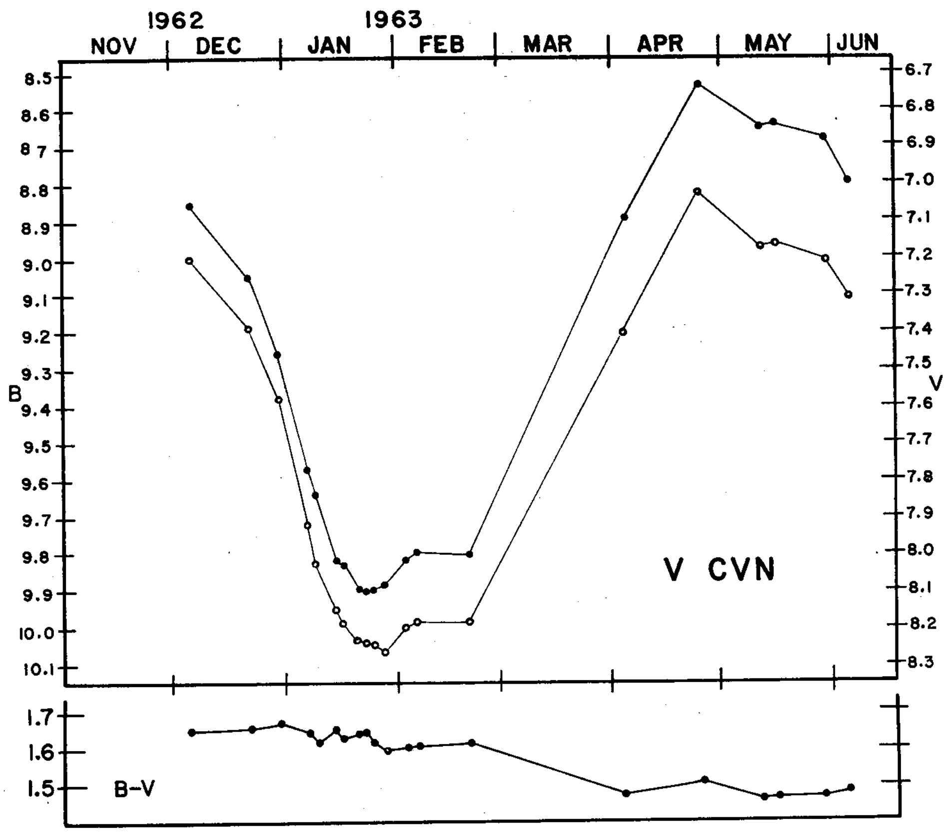

Fig. 5

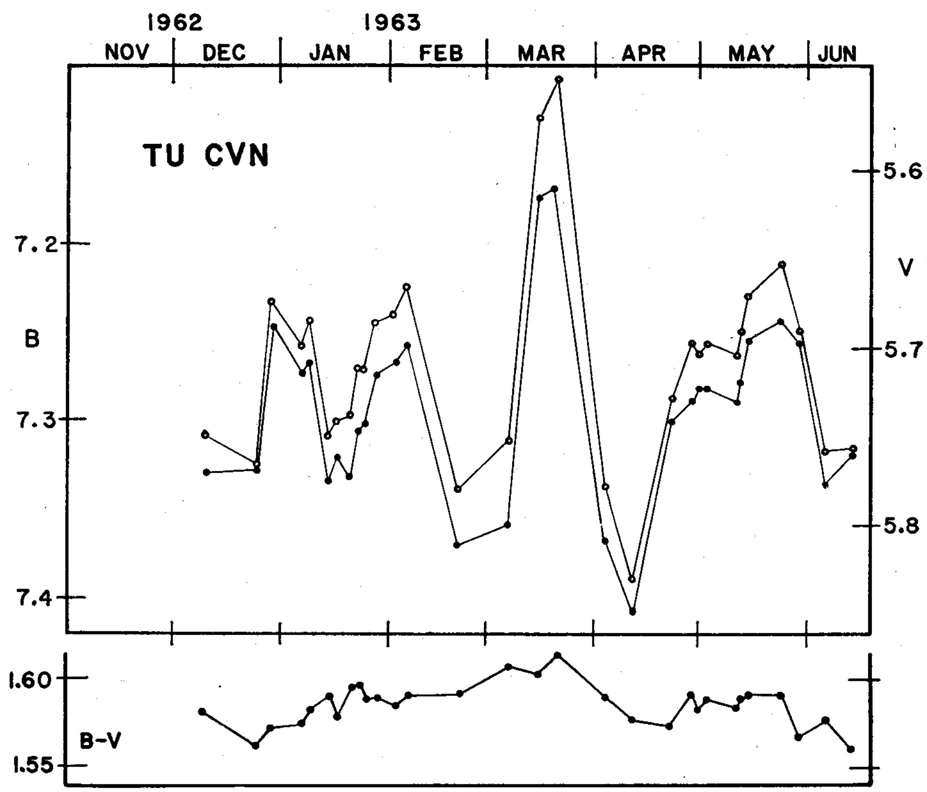

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Fig. 6

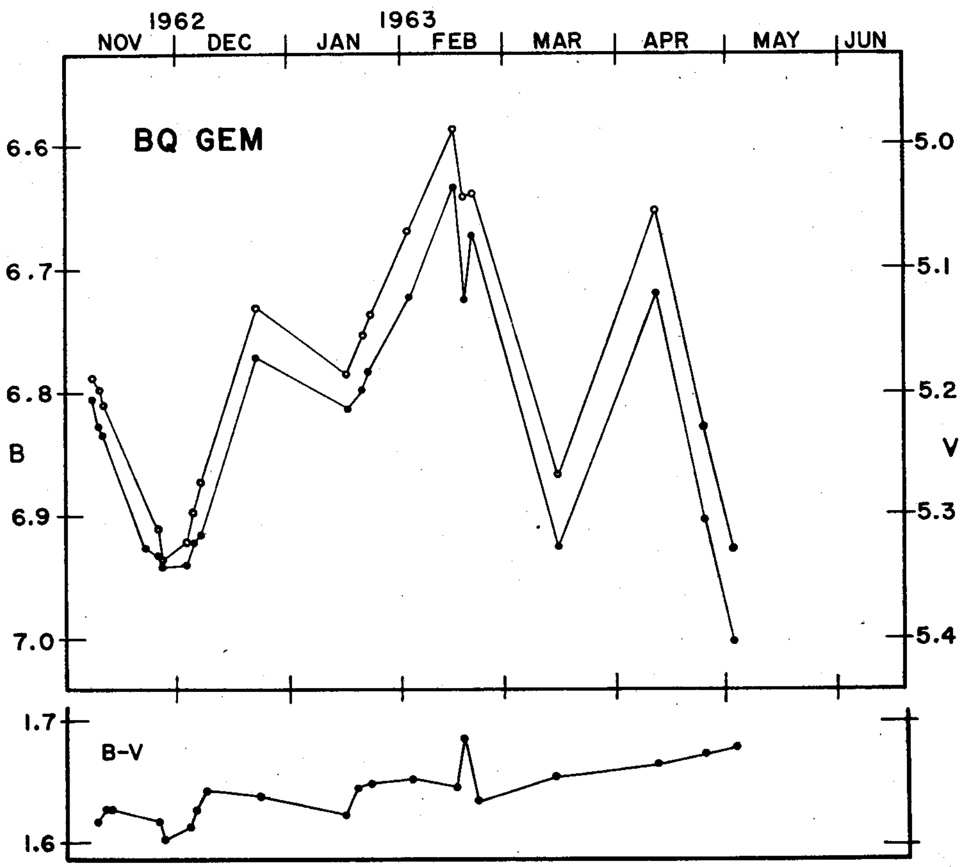
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Fig. 7

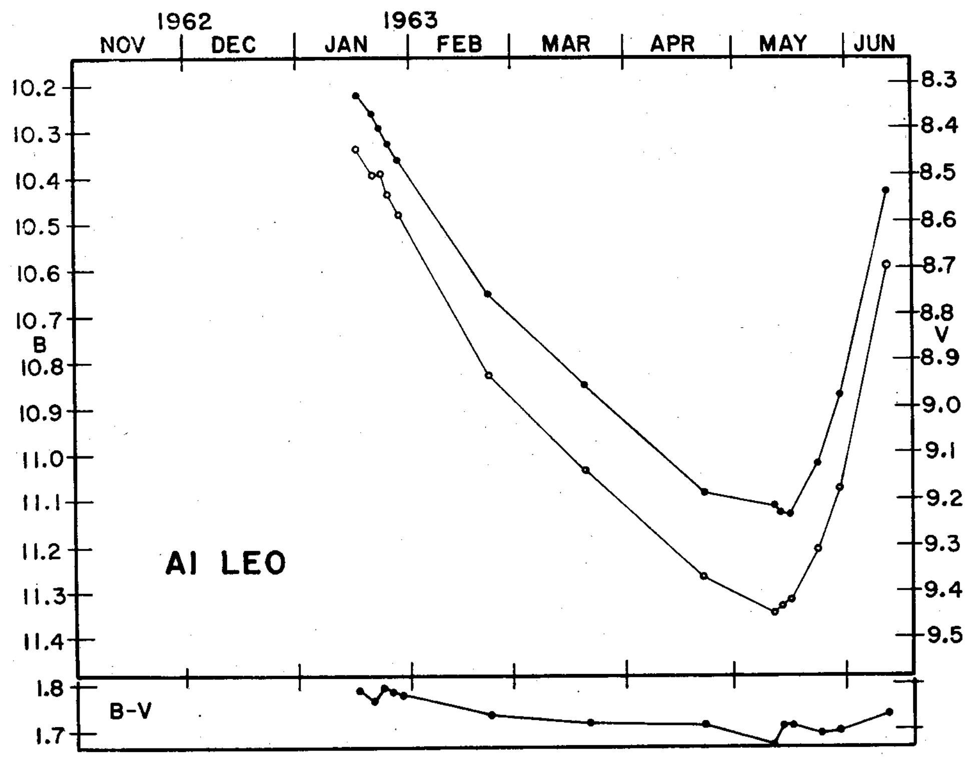
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Fig. 8

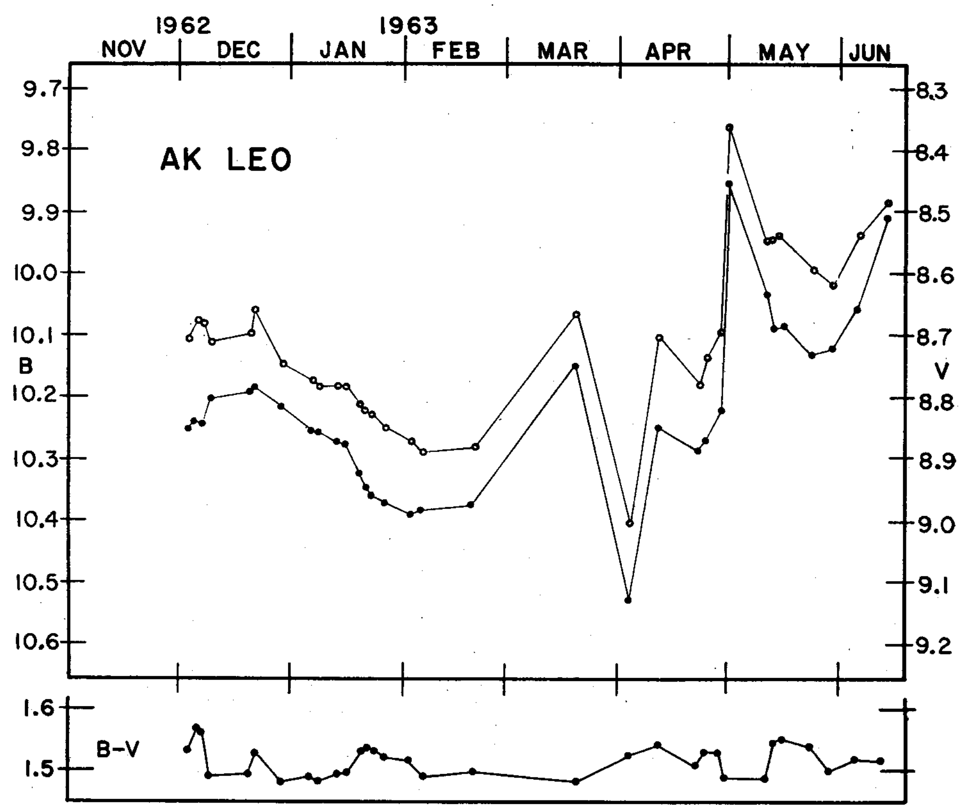
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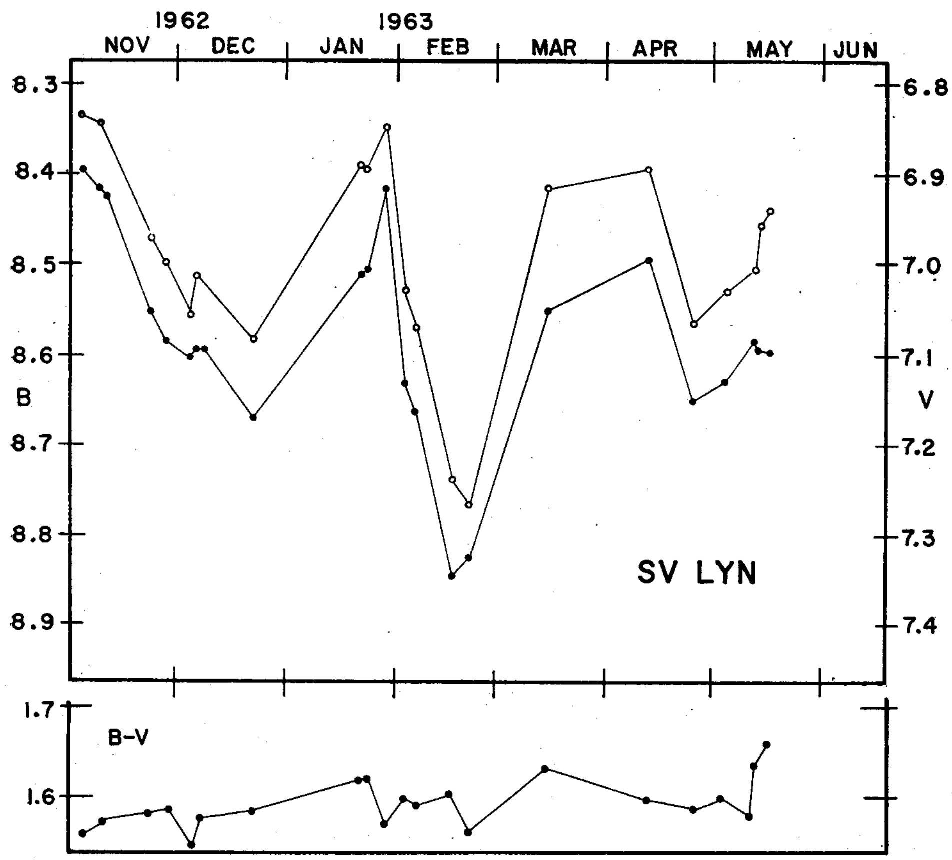
Fig. 9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V
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SV LYN
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B-V
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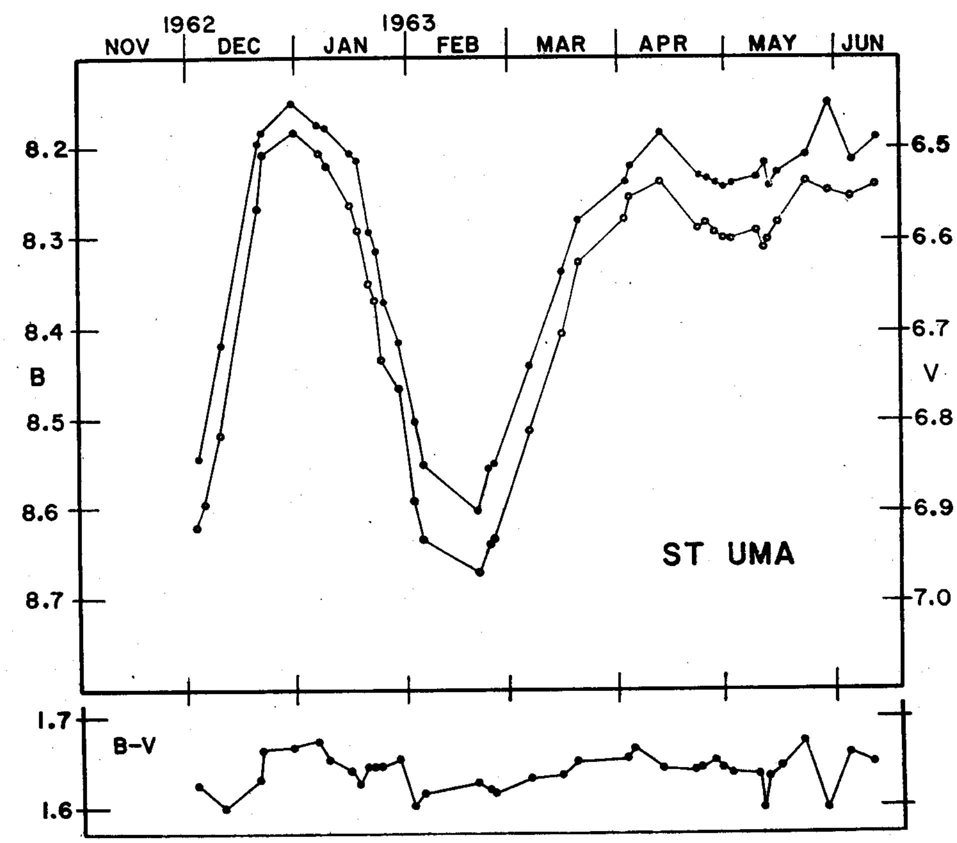
Fig. 10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V
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ST UMA
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B-V
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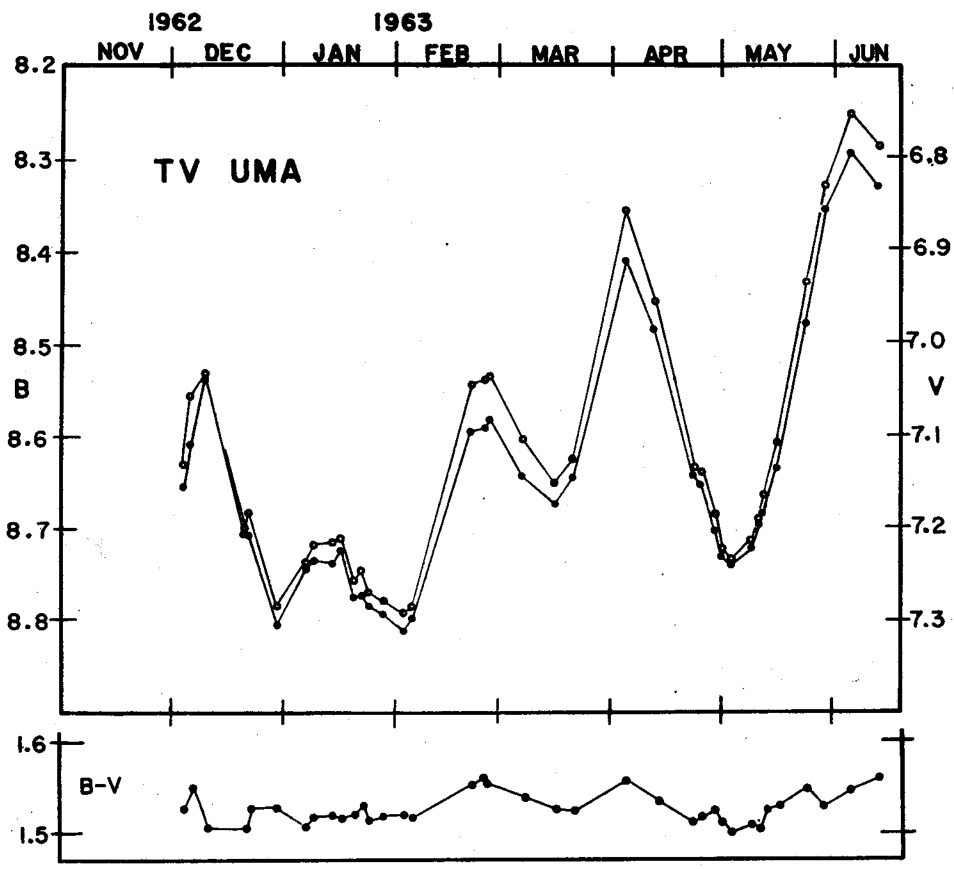
Fig. 11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B-V
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Fig. 12

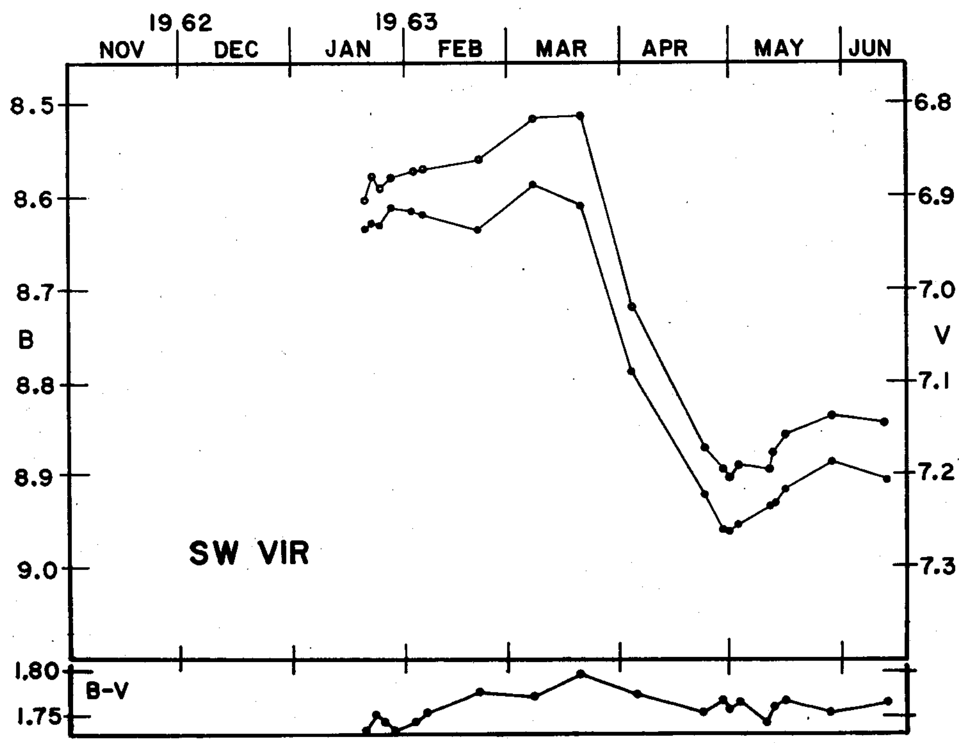
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Fig. 13

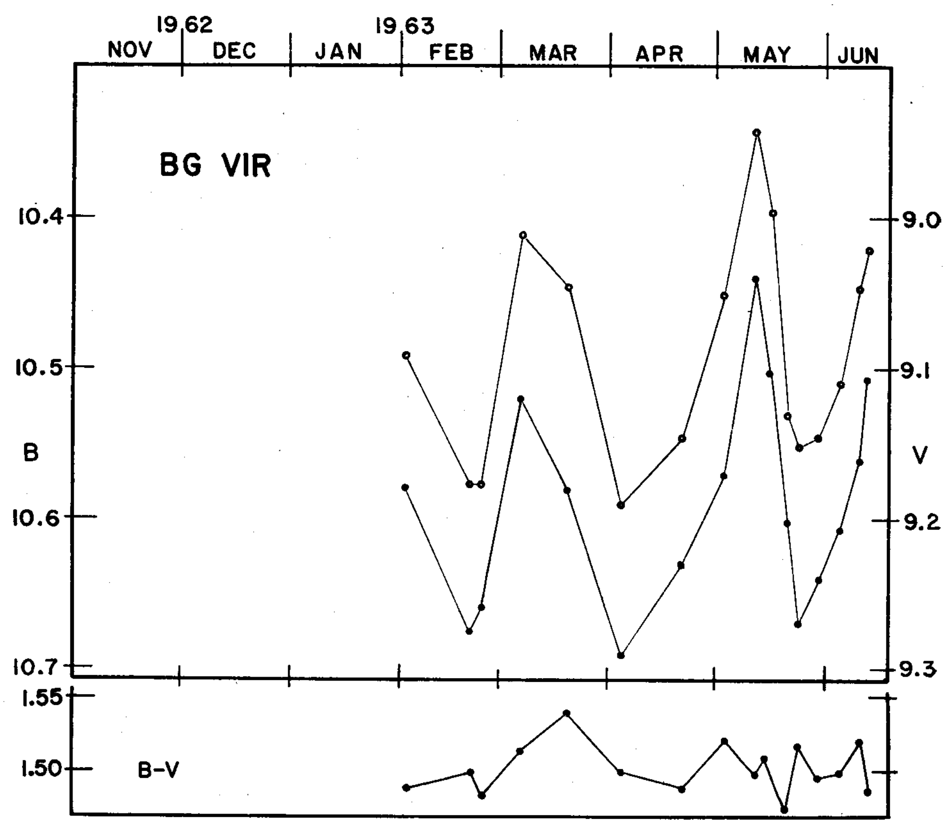
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Fig. 14

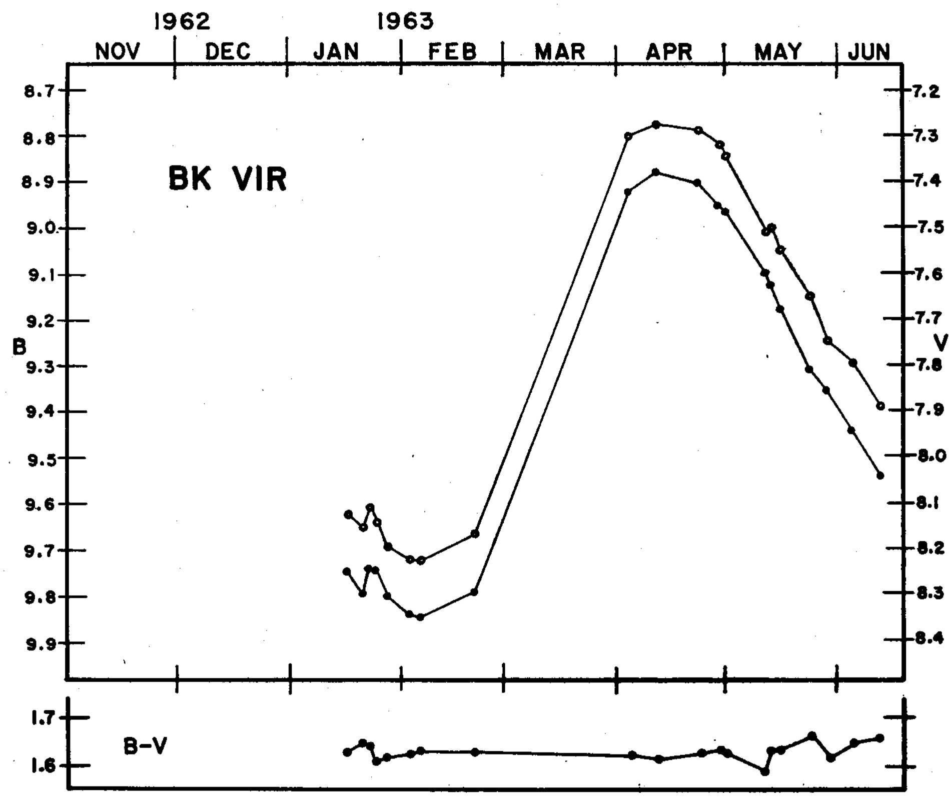

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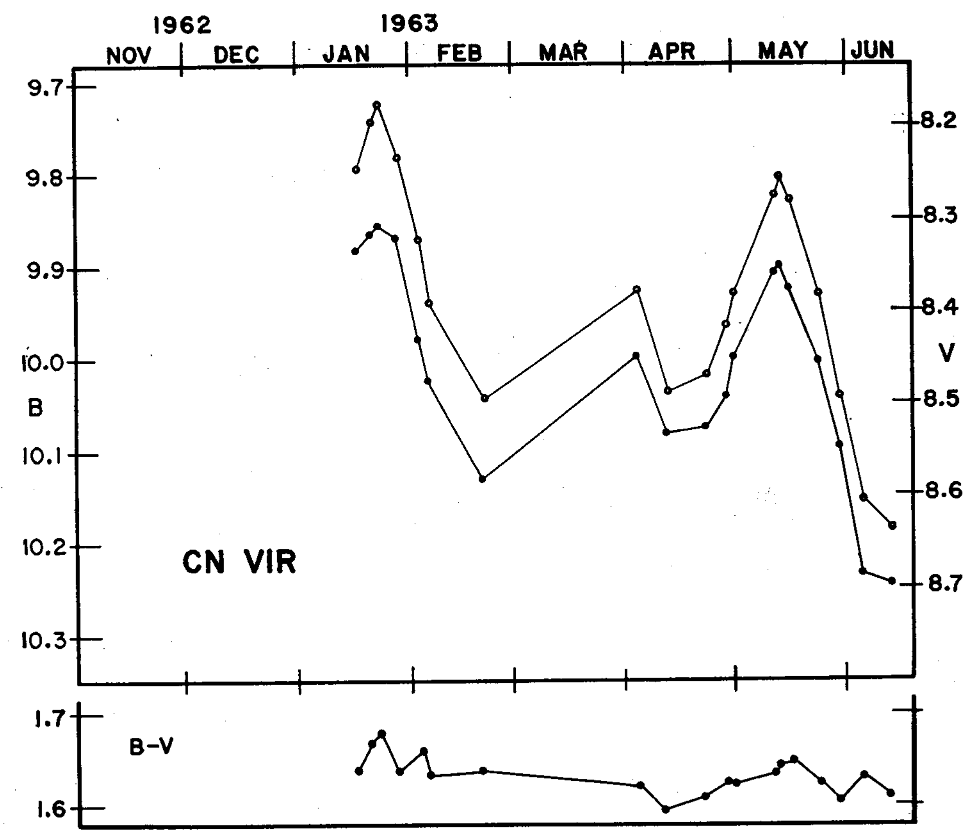
Fig. 15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CN VIR
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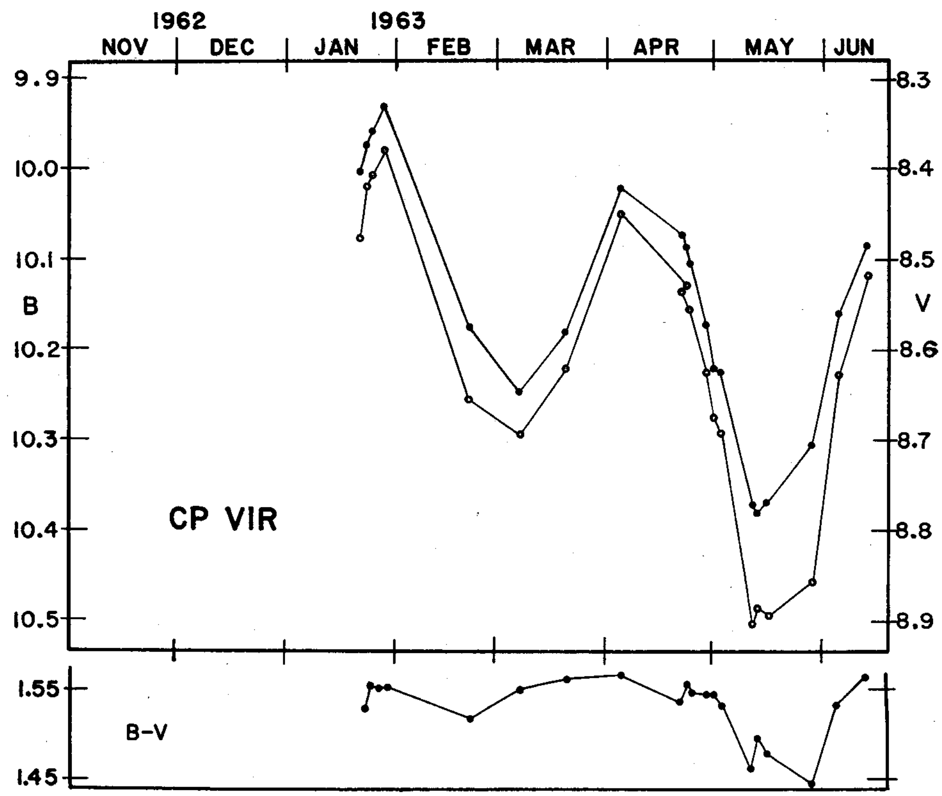
Fig. 16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CP VIR
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B-V
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Fig. 17

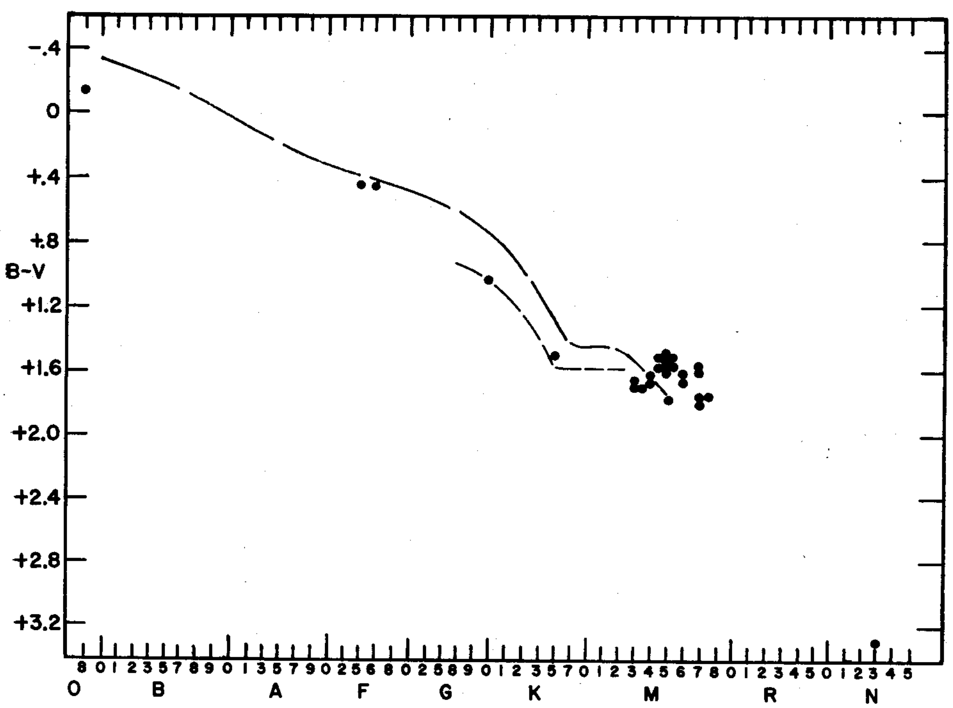
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Fig. 18

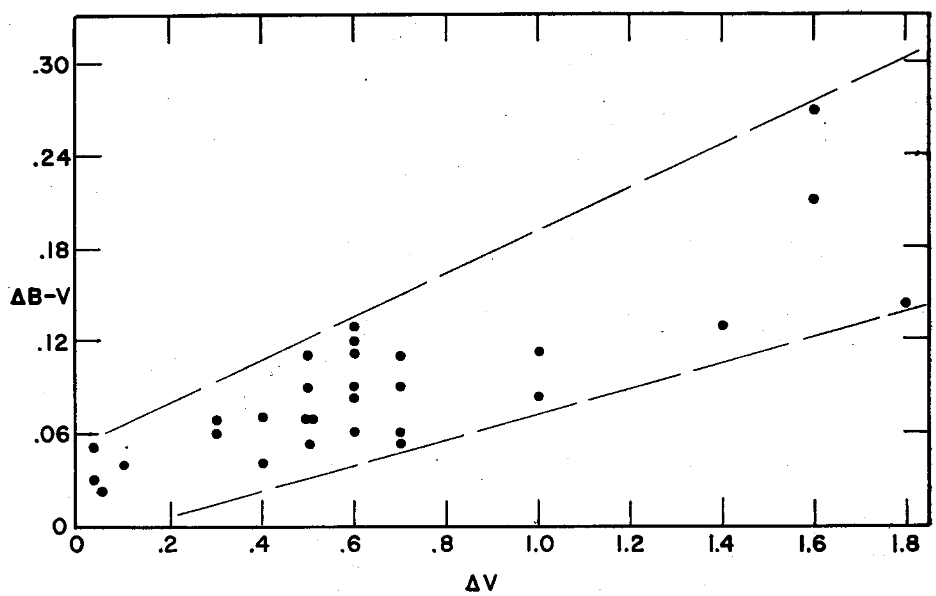

Fig. 19

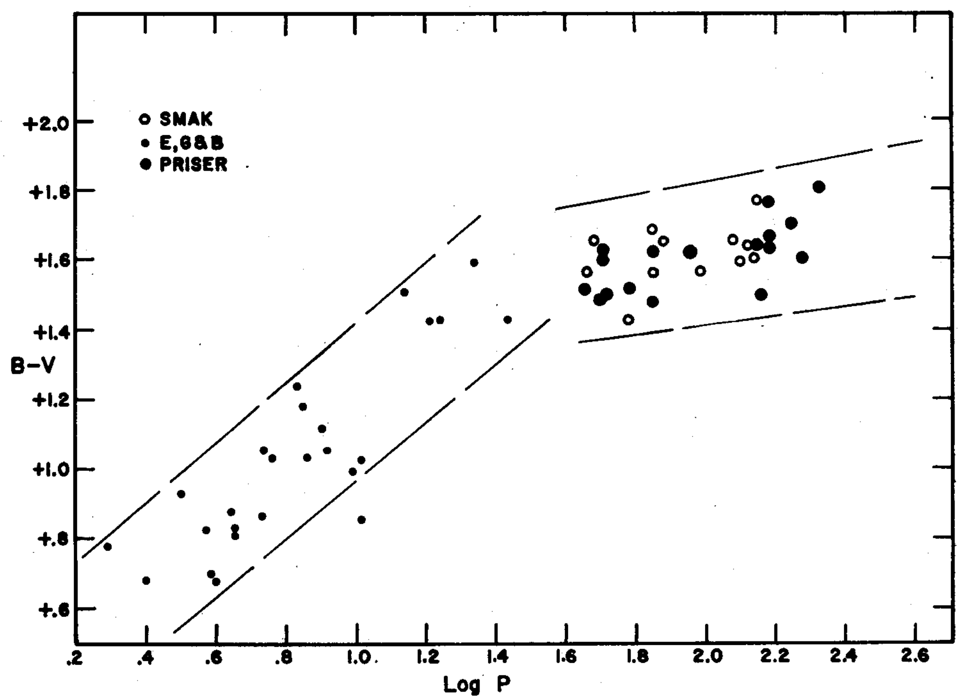

Fig. 20

TEXT REFERENCES

Eggen, O. J., Gascoigne, S.C.B., and Burr, E. J., 1957, *M.N.R.A.S.*, *117*, 406.
Johnson, H. L. and Harris, D. L., 1954, *Ap. J.*, *120*, 196.
Johnson, H. J. and Morgan, W. W., 1953, *Ap. J.*, *117*, 313.
Kron, G. E. and Svolopoulas, S. N., 1959, *P.A.S.P.*, *71*, 126.
Serkowski, K., 1961, *Lowell Bull.*, *V*, 157.
Smak, J., 1964,*Ap. J. Supplement*, *9*, 159.

A kiadásért felelős: Detre László Műszaki szerkesztő: Merkly László
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ON THE HIGH PRESSURE BEHAVIOUR OF HYDROGEN AND HELIUM

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S. BARCZA

The purpose of this paper is to obtain an exact equation of state for hydrogen and helium at $T = 0$ °K. For the derivation of the energy-molar volume function a cellular method is applied using the boundary condition $(\partial \varrho/\partial r)_{r=r_s} = 0$, where ϱ and r_s are the electron density and the radius of the elementar sphere, respectively. This condition may be satisfied by $(\partial \psi/\partial r)_{r=r_s} = 0$ or $\psi(r_s) = 0$. Both cases are examined. The modification of the Balmer series as a function of density is derived, and a qualitative indication suggesting the presence of a pressure ionization obtained, which may be of interest for geophysics too.

1. INTRODUCTION

One of the most important problems of astrophysics is the satisfactory description of hydrogen and helium under very high pressures: an adequate equation of state should be given for this case. Considering the relationship $p = -(\partial G/\partial v)_T$ the task is to give the free energy G as a function of molar volume v.

In this paper first the behaviour of hydrogen under high pressure is discussed, then the examination of helium follows. In the considerations on hydrogen the method developed by J. de Boer, J. Korringa and R. Kronig [1] is adopted, yet owing to a different numerical solution, not only the variation of ground-state energy as a function of density, but the whole energy spectrum of hydrogen i.e. the analogue of the Balmer series at high pressures is obtained.

E. Wigner and H. B. Hunington [2] were the first to prove that metallic hydrogen may exist at high pressures. They have also calculated the internal energy of metallic hydrogen. The essence of their method was, that the boundary condition

$$\left.\frac{d\psi}{dr}\right|_{r=r_s} = 0 \tag{1}$$

that has stood the test in the description of monovalent metals, applies also to hydrogen under high pressure. (In the formula ψ is the wave function of an electron, and r_s the radius of the elementary sphere for a hydrogen atom.)

In connection with the Kuhn–Rittman Earth model the behaviour of hydrogen under high pressure has come to the foreground again. De Boer and others have solved the Schrödinger equation by taking boundary condition (1) into consideration: they have determined the function $\varepsilon_0(r_s)$. (ε_0 is the energy of the first stationary orbit, which means that for $T = 0°$ K the calculation can be assumed to be exact). From this, they calculated the critical pressure of the formation of the metallic phase; for the molecular phase they used the Lennard–Jones potential, also called as 6–12 potential. This has a greater significance for the discussion of giant planets; considering the excessive pressures and temperatures, in astrophysical applications molecular hydrogen may occur only exceptionally.

With respect to the internal consitution of Jupiter and Saturn, W. C. DeMarcus [4, 5] repeatedly determined the function $\varepsilon_0(r_s)$ for atomic hydrogen. DeMarcus has not given the details of his calculations, he only mentions having followed the Wigner and Hunington method and used a variation wave function of three parameters. Above 300 000 atmospheres his results are in fair agreement with those of de Boer and others.

To calculate the internal energy of electron gas in divalent metals S. Raimes [6] has described a method. His results are fairly consistent with the high-pressure test results of Bridgman. DeMarcus mentions that he applied the same method for the determination of the equation of state of helium. Raimes' results are reliable up to about 10^5 atmospheres for metals. Therefore DeMarcus' extrapolation should be regarded with some reserve, as in the centre of Jupiter a pressure of about 10^8 atmospheres predominates. (The electrostatic interaction of helium electrons cannot be taken into account by this method quantum mechanically as the Hamiltonian operator does not contain any terms including the relative position vector r_{12} of two electrons.)

2. SPECTRUM OF HYDROGEN AT HIGH PRESSURES

First of all it should be made clear that in what follows by high pressures we mean 10^8 to 10^{10} atmospheres. Under such conditions the problem may still be treated in a non-relativistic approach; the Schrödinger equation must be solved, subject to boundary condition (1) in addition to regularity at the origin. This gives the following picture of the material under compression: individual hydrogen atoms come closer as pressure goes increasing and the regularity of the wave function can be ensured only by boundary condition (1).

Calculations are made in the usual atomic units, i.e.

$$\hbar = m_e = e = 1 \tag{2}$$

and energy is measured in ry units.

Then the Schrödinger equation becomes

$$\left(\Delta + \frac{2Z}{r} + \varepsilon\right)\psi = 0. \tag{3}$$

Since the boundary condition (1) preserves spherical symmetry, the radial part of the wave function can be separated in the same way, as in the case of a free hydrogen atom; thus the equation of the radial part of the wave function is:

$$\varphi'' + \frac{2}{r}\varphi' + \left(\varepsilon + \frac{2Z}{r} - \frac{l(l+1)}{r^2}\right)\varphi = 0. \tag{4}$$

The boundary condition is

$$\left.\frac{d\varphi}{dr}\right|_{r=r_s} = 0. \tag{5}$$

In what follows we limit our considerations to the s states, i.e. we take $l = 0$. (In ground state, there is no other possibility, and only excitations of state s will be examined. In addition the results will show that above certain pressures electrons may exist only in the state $1s$).

Thus the problem is to solve the differential equation

$$\varphi'' + \frac{2}{r}\varphi' + \left(\varepsilon + \frac{2Z}{r}\right)\varphi = 0 \tag{6}$$

by taking (5) into consideration. With the transformation

$$\varphi(r) = e^{-t/2} F(t) \tag{7}$$

where

$$t = 2r\sqrt{|\varepsilon|} \tag{8}$$

equation (6) becomes a confluent hypergeometric differential equation of index $c = 2$, namely

$$tF'' + (2 - t)F' - \alpha F = 0 . \tag{9}$$

The parameter α includes the energy eigenvalue

$$\alpha = 1 - \frac{Z}{\sqrt{|\varepsilon|}} \tag{10a}$$

$$\varepsilon = -\frac{Z^2}{(1-\alpha)^2} . \tag{10b}$$

It can be seen that the stationary states with the $n = 1, 2, 3 \ldots$ main quantum numbers belong to the values $\alpha = 0, -1, -2, \ldots$ The solution of equation (9) is a confluent hypergeometric function

$$F_\alpha(t) = \sum_{k=0}^{\infty} \frac{(\alpha)_k}{(k+1)!}\frac{t^k}{k!} \tag{11}$$

where

$$(\alpha)_k = \alpha(\alpha+1)\ldots(\alpha+k-1)$$

and

$$(\alpha)_0 = 1 .$$

As it could be expected, for not positive integer values of α Equ. (11) is a polinom of order $k \geq 0$ and for other values of α it is a uniformly convergent infinite series.

Consider the boundary condition

$$\left.\frac{d\varphi}{dr}\right|_{r=r_s} = 2\sqrt{|\varepsilon|}\, e^{-t/2}\left[F'(t) - \frac{1}{2}F(t)\right]\Bigg|_{t=t_s} = 0 . \tag{12}$$

As

$$t = \frac{2Zr}{1-\alpha} \tag{13}$$

after the transposition of the form of the $F(t)$ series Equ. (12) is transformed into

$$\frac{1}{2}+\sum_{k=1}^{\infty}\left[\frac{(2Z)^k}{(k-1)!\,(k+1)!}\,\frac{(\alpha)_k}{(1-\alpha)^k}\,r_s^k\left(\frac{1}{2k}-\frac{1-\alpha}{2Zr_s}\right)\right]=0\,. \qquad (14)$$

It only α occurs in (14) and after solution for various r_s values, on the basis of (10b) the required $\varepsilon(r_s)$ function may be written down. The equation is of infinite degree, but the term $[(k-1)!(k+1)!]^{-1}$ ensures convergency for any finite value of r_s.
Therefore, in the numerical solution the equation

$$H_n(\alpha)=\frac{1}{2}+\sum_{k=1}^{n}\left[\frac{(2Z)^k}{(k-1)!\,(k+1)!}\,\frac{(\alpha)_k}{(1-\alpha)^k}\,r_s^k\left(\frac{1}{2k}-\frac{1-\alpha}{2Zr_s}\right)\right]=0 \qquad (15)$$

will be solved for a finite value of n great enough to comply with the required accuracy of α (one-thousandth part in this paper). The solution thus obtained is represented in Figure 1 and 2; for large r_s values $\varepsilon(r_s)$ gives the Balmer series again.

The mathematical reason of the different behaviour of the states $n = 1$ and $n > 1$ is that the eigenfunction of the state $n = 1$ is an exponential function, whereas in case of $n > 1$ it is the product of a polynomial of order $k \geq 1$ and of an exponential function. Following from the uncertainty principle in the course of compression the drop of potential energy is at first more rapid than the increase of the kinetic energy coming from localisation, because

$$V_{\text{pot}} \sim -\frac{1}{r_s} \qquad E_{\text{kin}} \sim \frac{1}{r_s^2}\,. \qquad (16)$$

This means that with the decrease of r_s, at first α must go increasing, that is to say, for $n = 1$ $0 < \alpha < 1$, for $n = 2$ $-1 < \alpha < 0$, $n = 3$ $-2 < \alpha < -1$.

$$F_0(t) \equiv 1 \qquad (17)$$

which is consistent with the fact that the eigenfunction of $n = 1$ is exponential. So that the energy eigenvalue of the ground state with decreasing r_s should likewise converge to zero, the condition

$$\lim_{r_s \to 0} \alpha = -\infty$$

should be fulfilled. ($\lim \alpha = +\infty$ is eliminated by the singularity in $\alpha = 1$). Considering those discussed above, $\alpha = 0$ will occur at some finite value of r_s. Then the eigenfunction becomes exponential again because of (17): on the other hand, its slope in finite is zero. This is an apparent contradiction. Yet the slope of the eigenfunction of the states $n > 1$ is zero not only in the infinite, and thus it is no contradiction that the relationship

$$\alpha = -(n-1) \qquad (18)$$

must be fulfilled at least for two values of r_s. (One of them is $r_s = \infty$).

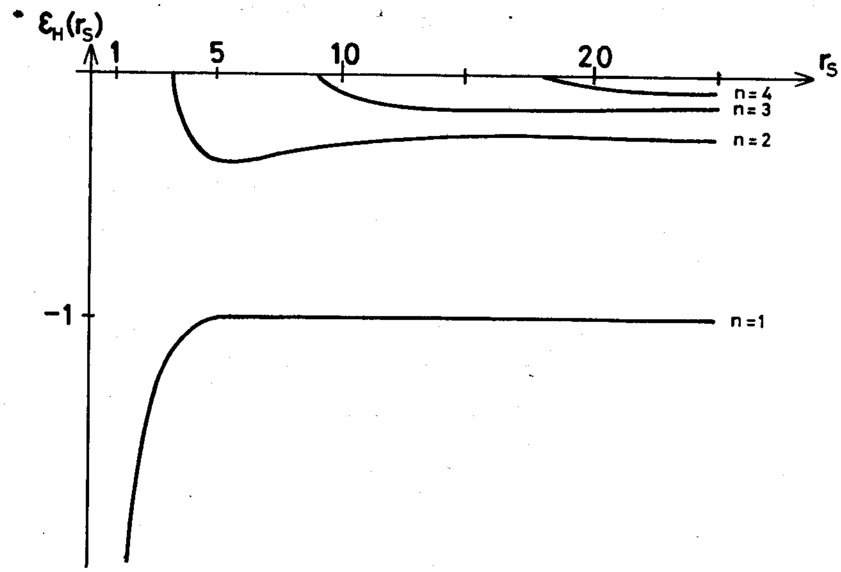

Figure 1

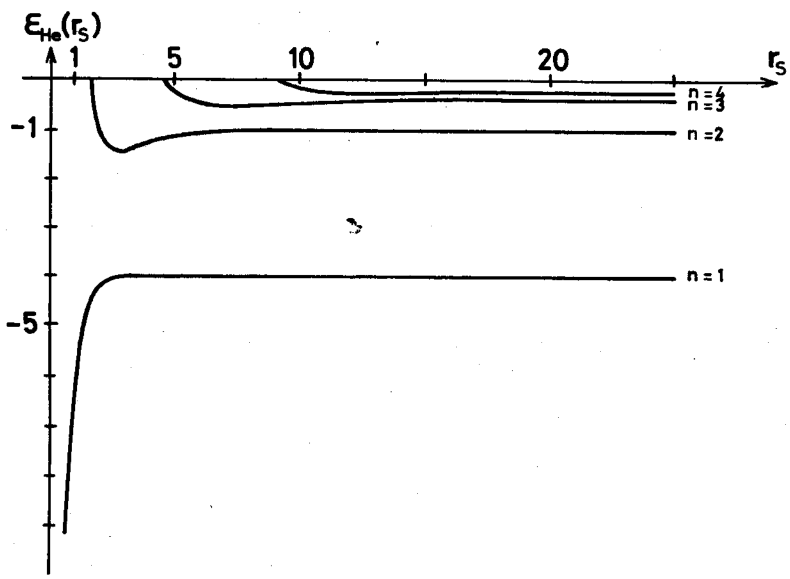

Figure 2

The Figures represent the course of the energy eigenvalues of various stationary states. The horizontal axis carries r_s in units of a_0 the vertical axis $\varepsilon(r_s)$ in ry units (a_0 is the first Bohr radius)

3. APPLICATIONS

a) The equation of state of atomic hydrogen may be derived from the well-known relationship

$$p = -\left(\frac{\partial G}{\partial v}\right)_T . \tag{19}$$

(At $T = 0$ °K we may take $G = E$.) It goes without saying that the overall energy, E, belonging to a single atom, which is composed of the sum of the Fermi, exchange, correlation and Coulomb energies [1, 4]

$$E_H(r_s) = \frac{2.21}{r_s^2} + \frac{1.20}{r_s} - \frac{0.916}{r_s} - \frac{0.88}{r_s + 7.8} + \varepsilon(r_s) \tag{20}$$

monotonously increases with the dropping of r_s. If (20) had a local minimum, this would correspond to the forming of some crystal structure. Transpose (20) into (19) and consider that mass density expressed in terms of cgs is

$$\varrho = \frac{2.679}{r_s^3} \tag{19a}$$

then the equation of state may be written as

$$p(\varrho) = 1.175 \times 10^{13} \left[0.855\, \varrho^{5/3} + 0.0763\, \varrho^{4/3} - \frac{0.236\, \varrho^{4/3}}{(1 + 5.61\, \varrho^{1/3})^2} + \right.$$
$$\left. + 1.118\, \varrho^2 \frac{d\varepsilon}{d\varrho} \right] \frac{\text{dyn}}{\text{cm}^2} . \tag{19b}$$

Substituting numerical values into (19b) for the case of $n = 1$ the equation of state given in Table 1 is obtained, in fair agreement with the DeMarcus equation of state. Discrepancies come among others, from the zero point energy neglected. Another source of discrepancy is the use of a three-parameter wave function instead of the exact formula, (7). The critical pressure of 1.93×10^6 atmospheres for the formation of the metallic phase is in very good accordance with DeMarcus' results. (For the molecular phase the "6—12" potential was used.)

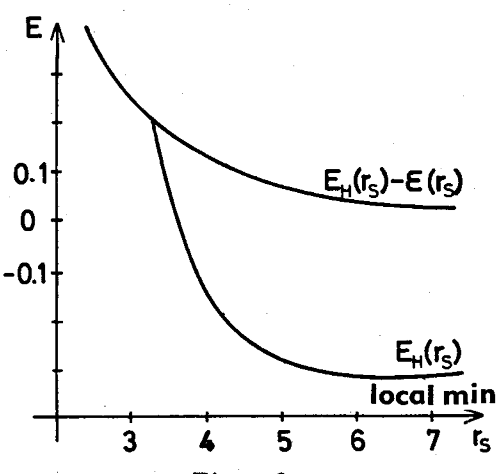

Figure 3

The unit for E is ry, that for r_s is a_0

b) For the case of $n = 2$, $E_H(r_s)$ is reptesented in Figure 3.

Figures 1, 2, 3 imply a conclusion much more interesting for geophysics as regards pressure ionization. It is seen that above a certain pressure (or density) only a single s bound state is found. This means that, if an atom, considered as spherically symmetrical for the sake of approximation, for which $Z > 2$, is compressed, $2s$, $3s$, ... electrons leave the atom bonds. (They become free as $E > 0$ for the stationary

Table 1

(The equation of state of the metallic hydrogen at 0 °K)

r_s (a_0)	ϱ (cgs)	p (cgs 10^{-12})	r_s	ϱ	p
			1.00	2.680	22.2
0.15	794.0	6.20×10^5	1.05	2.314	14.3
0.20	335.0	1.37×10^5	1.10	2.013	10.7
0.25	171.5	3.79×10^4	1.15	1.762	7.57
0.30	99.55	1.36×10^4	1.20	1.551	5.51
0.35	62.50	6.04×10^3	1.25	1.372	4.00
0.40	41.87	3.04×10^3	1.30	1.220	2.92
0.45	29.41	1.56×10^3	1.35	1.089	2.10
0.50	21.44	964	1.40	0.9766	1.47
0.55	16.11	446	1.45	0.8789	0.955
0.60	12.40	327	1.50	0.7940	0.646
0.65	9.758	195	1.55	0.7196	0.419
0.70	7.812	127	1.60	0.6542	0.233
0.88	3.930	42.0	1.65	0.5965	0.125

state.) As seen in Figure 3, such phase transformation is accompanied by a density jump as pressure is in proportion to the slope of the curve. Setting Figures 1, 2 side-by-side it is seen that the higher the atomic number the higher the density (pressure) at which this phenomenon takes place. By a further development of this train of ideas the density jumps in the interior of the Earth could be explained supposing that different metallic phases of the chemically homogeneous material of the Earth, produced in the way outlined above, form mantle, core and inner core.

4. EQUATION OF STATE OF HELIUM IN CASE OF $T = 0$ °K

In the first part of this paper the eigenfunction of hydrogen for various r_s values was obtained, so to speak, "incidentally". It is reasonable to try to determine the ground-state energy of a helium atom as a function of r_s, too, as for the first approximation of the perturbation theory: to the calculation of $(\varphi_0, H_1\,\varphi_0)$ everything is at hand. By this, as a matter of fact, the Wigner–Seitz cellular method has been applied to helium, considering the interaction within the elementary cell quantum-mechanically. The eigenfunction of helium will be constructed as a product of eigenfunctions of the type of Equation (7) and, considering that because of $T = 0$ °K the space-dependent part is symmetrical:

$$\varphi_0 = e^{-2\frac{r_1+r_2}{1-\alpha}}\, F\left(\frac{4r_1}{1-\alpha}\right) F\left(\frac{4r_2}{1-\alpha}\right). \tag{21}$$

The boundary condition imposed on the wave function will be determined so that the slope of electron density is zero at the surface of the elementary cell. As the electrons are in the state $1s$, the density of electrons at place r is:

$$\varrho(r) = \varphi_0^2(r). \tag{22}$$

Differentiating and taking it at the boundary of the cell

$$\left.\frac{d\varrho}{dr}\right|_{r=r_s} = 2\,\varphi_0'(r_s)\,\varphi_0(r_s) = 0\,. \tag{22a}$$

Expression (22a) may be zero when $\varphi_0'(r_s)$ or $\varphi_0(r_s)$ are equal to zero. In the first case the solution of (14) and (15) gives the function $\alpha(r_s)$ wanted, as, because of symmetry

$$\mathrm{grad}_1\,\varphi_0\,|_{r=r_s} = \mathrm{grad}_2\,\varphi_0\,|_{r=r_s} = 0 \tag{22b}$$

where grad_1 is derivation with respect to the coordinate of the first, and grad_2 derivation with respect to the coordinate of the second electron.

The energy becomes

$$\varepsilon^1_{He} = \frac{(\varphi_0, H\varphi_0)}{(\varphi_0, \varphi_0)} \tag{23}$$

where

$$H = -\Delta_1 - \Delta_2 - 2\left(\frac{Z}{r_1} + \frac{Z}{r_2}\right) + \frac{2}{r_{12}} = H_0 + H_1\,. \tag{24}$$

The contribution of the non-perturbed Hamiltonian operator H_0 to (23) is $2\,\varepsilon_{He^+}(r_s)$. i.e.

$$\varepsilon^1_{He}(r_s) = 2\,\varepsilon_{He^+}(r_s) + \frac{(\varphi_0, H_1\,\varphi_0)}{(\varphi_0, \varphi_0)}\,. \tag{25}$$

Thus the problem is reduced to the determination of the increment due to the operator H_1. To calculate this the following relationships are needed.

$$F^2(t) = \sum_{k=0}^{\infty} c_k'\,t^k = \sum_{k=0}^{\infty}\left(\sum_{l=0}^{k} c_l\,c_{k-l}\right) t^k \tag{26}$$

where

$$c_k = \frac{(\alpha)_k}{k!(k+1)!}$$

$$\int_0^{t_s} e^{-t}\,t^n\,dt = -\sum_{m=0}^{n}\frac{n!}{(n-m)!}\left[e^{-t}\,t^{n-m}\right]_{t=0}^{t=t_s}\,. \tag{27}$$

As nothing can depend on the position in space of the helium atom, and the electrons are in state s, after integration with respect to one, respectively to two polar angles of six-dimension elementary volume position vectors r_1 and r_2 we may write

$$dV = 8\pi^2\,r_1^2\,r_2^2 \sin\vartheta\,d\vartheta\,dr_1\,dr_2 \tag{28a}$$

or, r_{12} having been introduced it takes the form

$$dV = 8\pi^2\,r_1\,r_2\,r_{12}\,dr_{12}\,dr_1\,dr_2\,. \tag{28b}$$

As $r_{12} = \sqrt{r_1^2 + r_2^2 - 2r_1 r_2 \cos\vartheta}$ integration with respect to r_{12} is carried out between the limits $|r_1 - r_2|$ and $r_1 + r_2$.

Considering the above, the normalization factor is

$$N = (\varphi_0, \varphi_0) = 16\pi^2 \int_0^{r_s} dr_1 \int_0^{r_s} dr_2\, r_1^2 r_2^2 \varphi_0^2. \tag{29}$$

As r_1 and r_2 are independent variables, the double integral becomes a product of single ones. Thus

$$N = 16\pi^2 \int_0^{r_s} e^{-\frac{4r_1}{1-\alpha}} F^2\left(\frac{4r_1}{1-\alpha}\right) r_1^2\, dr_1 \int_0^{r_s} e^{-\frac{4r_2}{1-\alpha}} F^2\left(\frac{4r_2}{1-\alpha}\right) r_2^2\, dr_2. \tag{30}$$

Introducing the notation

$$G_2(r_s, \alpha) = \int_0^{r_s} e^{-\frac{4r}{1-\alpha}} F^2\left(\frac{4r}{1-\alpha}\right) r^2\, dr \tag{31}$$

and using Eqs (13), (27) we can perform the integration:

$$G_2(r_s, \alpha) = \left(\frac{1-\alpha}{4}\right)^3 \sum_{k=0}^{\infty} c_k' \left[(k+2)! - e^{-t_s} \sum_{m=0}^{k+2} \frac{(k+2)!}{(k+2-m)!} t^{k+2-m}\right]$$

$$= \left(\frac{1-\alpha}{4}\right)^3 e^{-\frac{4r_s}{1-\alpha}} \sum_{m=0}^{\infty} c_k' p^{k+2} \tag{31a}$$

where

$$p^k = k!\left[1 - e^{-t_s} \sum_{m=0}^{k} \frac{t_s^k}{(k-m)!}\right] = \sum_{m=k+1}^{\infty} \frac{k!}{m!} \left(\frac{4r_s}{1-\alpha}\right)^m. \tag{31b}$$

Thus

$$N = 16\pi^2 [G_2(r_s, \alpha)]^2. \tag{32}$$

The potential energy correction for repulsion between two electrons is

$$\begin{aligned} L_p = (\varphi_0, H_1 \varphi_0) &= 16\pi^2 \int_0^{r_s} dr_1 \int_0^{r_s} dr_2 \int_{|r_1-r_2|}^{r_1+r_2} dr_{12}\, r_1 r_2 \varphi_0^2 \\ &= 32\pi^2 \int_0^{r_s} dr_1 \left(\int_0^{r_1} dr_2\, r_1 r_2^2 \varphi_0^2 + \int_{r_1}^{r_s} dr_2\, r_1^2 r_2 \varphi_0^2\right). \end{aligned} \tag{33}$$

Using form (21) for φ_0 and integrating with respect to r_2 we get

$$\begin{aligned} L_p = 32\pi^2 \left(\frac{1-\alpha}{4}\right)^5 \Bigg\{ &\int_0^{t_s} e^{-t} \left(\sum_{l=0}^{\infty} c_l' t^{l+1}\right) \left[\sum_{k=0}^{\infty} c_k'(k+2)! \left(1 - e^{-t} \sum_{m=0}^{k+2} \frac{t^m}{m!}\right)\right] dt \\ &+ \int_0^{t_s} e^{-t} \left(\sum_{l=0}^{\infty} c_l' t^{l+2}\right) \left[\sum_{k=0}^{\infty} c_k'(k+1)! \left(\sum_{m=0}^{\infty} \frac{e^{-t} t^m}{m!} - \frac{e^{-t_s} t_s^m}{m!}\right)\right] dt \Bigg\}. \end{aligned} \tag{34}$$

Apply the Cauchy rule for the multiplication of infinite series and use (27) again to obtain

$$L_p = 32\pi^2 \left(\frac{1-\alpha}{4}\right)^5 \sum_{l=0}^{j} c_l' \Bigg\{ e^{-t_s} \left[\sum_{k=0}^{l+k=j} c_k'(k+1)! \left((k+2)\,p^{l+1} - e^{-t_s} p^{l+2} \sum_{m=0}^{k+1} \frac{t_s^m}{m!} \right) \right]$$
$$+ \sum_{k=0}^{l+k=j} c_k'(k+1)! \left[\sum_{m=0}^{k+1} \frac{(m+l+2)!}{2^{m+l+3}\, m!} \left(1 - e^{-2t_s} \sum_{p=0}^{m+l+2} \frac{(2t_s)^p}{p!} \right) \right. \tag{35}$$
$$\left. -(k+2) \sum_{m=0}^{k+2} \frac{(m+l+1)!}{2^{m+l+2}\, m!} \left(1 - e^{-2t_s} \sum_{p=0}^{m+l+1} \frac{(2t_s)^p}{p!} \right) \right] \Bigg\} .$$

Equation (35) was computed on an Ural-2 type computer. The numerical results are listed in Table 2. In the range of $0.1 \leq r_s \leq 3.5$ for L_p/N $j \leq 20$ they are reliable one part in thousandth.

The total energy for each helium electron can be set up on the analogy of (20); considering, that a sphere of radius r_s now contains two electrons:

$$E_{He}(r_s) = \frac{3.51}{r_s^2} + \frac{2.40}{r_s} - \frac{1.154}{r_s} - \frac{1.109}{r_s + 9.38} + \frac{1}{2}\, \varepsilon^1_{He}(r_s). \tag{36}$$

Using Eq. (19) the equation of state for $T = 0$ °K can be derived

$$p = \frac{1.475 \times 10^{14}}{4\pi r_s^2} \left[\frac{14.04}{r_s^3} + \frac{2.492}{r_s^2} - \frac{2.21}{(r_s + 9.83)^2} - \frac{d\varepsilon^1_{He}}{dr_s} \right] \frac{\text{dyn}}{\text{cm}^2} . \tag{37}$$

Table 2 lists the numerical values of (25) and of interaction energy, (37) as functions of density. ($\varrho = 10.85\ r_s^{-3}$ cgs)

Table 2

(The helium at 0 °K)

r_s (a_0)	$\varepsilon_{He}(r_s)$ (ry)	L_p/N (ry)	p (cgs $\times 10^{-12}$)	r_s	$\varepsilon_{He}(r_s)$	L_p/N	p
0.15	−64.67	16.13	2.22×10^6	1.50	−7.638	2.110	7.33
0.20	−48.67	12.13	4.60×10^5	1.60	−7.288	2.084	5.61
0.25	−39.13	9.746	1.69×10^5	1.70	−6.995	2.077	3.76
0.30	−32.71	8.152	6.62×10^4	1.80	−6.727	2.090	2.76
0.35	−28.16	7.017	2.56×10^4	1.90	−6.509	2.115	2.16
0.40	−24.77	6.165	1.29×10^4	2.00	−6.309	2.157	1.81
0.45	−22.11	5.505	6.86×10^3	2.10	−6.153	2.197	1.50
0.50	−20.00	4.976	3.94×10^3	2.20	−6.013	2.245	1.31
0.60	−16.85	4.191	1.49×10^3	2.30	−5.893	2.293	1.23
0.70	−14.58	3.639	637	2.40	−5.802	2.334	1.26
0.80	−12.91	3.228	307	2.50	−5.726	2.370	1.29
0.90	−11.61	2.917	156	2.60	−5.677	2.395	1.22
1.00	−10.55	2.678	83.6	2.70	−5.635	2.417	1.08
1.10	− 9.769	2.488	53.4	2.80	−5.590	2.444	0.972
1.20	− 9.093	2.349	29.0	2.90	−5.577	2.451	0.869
1.30	− 8.525	2.237	19.0	3.00	−5.561	2.459	0.788
1.40	− 8.050	2.160	11.8	3.20	−5.527	2.481	0.633
				3.50	−5.507	2.493	0.466

The values obtained for pressures do not agree with the empirical values at low densities. This is by no means surprising, as the Fermi gas model of the material does not give a correct description here. Non-metallic helium was described as if its behaviour under high pressures were dependent on an elec-

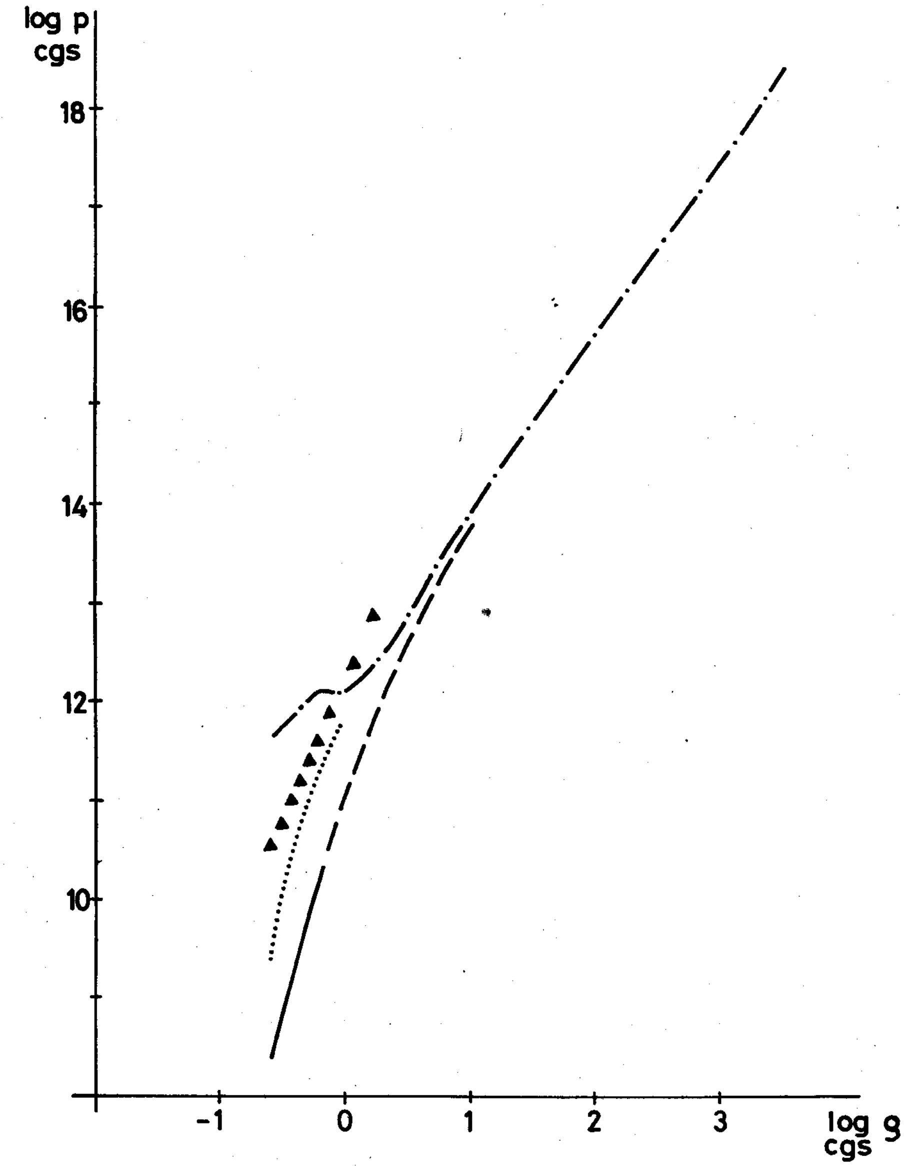

Figure 4

———— Experimental curve of Stewart

— — — — Extrapolation of equation of state of DeMarcus

—·—·—·— Numerical values of (37)

The comment for the two other curves can be found on the next page.

tron gas similar in some respects to that found in divalent metals. As, however, pressure goes increasing, (37) should become of ever better reliability. As the paper of Raimes indicates and a numerical comparison shows, the part falling into the 10^6–10^7 atmosphere range of the DeMarcus' equation of state corresponds to $L_p(r_s) = 0$ which makes the matter under compression softer than in reality it is. DeMarcus selected the low-pressure section apparently in order to get a good interpolation between experimental and high-pressure sections.

Only in the possession of an equation of state of better reliability one could judge the question, how close the phase transformation represented in Figure 4 comes to reality. It should take place at about one million atmospheres, and the density jump that occurs is of about 0.3 gcm^{-3}. This result, provided it is confirmed by further calculations, may be of outstanding importance in the discussion of giant planets, and may give a new basis for looking for the origins of discontinuities in the core of the Earth in the formation of the electron structure of a homogeneous silicate material as outlined above.

For a better agreement at low pressures the fulfillment of boundary condition (22a) was examined also in the case when the wave function itself is zero. Then, of course, electron density on the surface of the elementary sphere is likewise zero, which corresponds to a most strict localization of the helium electrons — the case of an ideal insulator of infinitely high potential barrier. Expressed by the terms of mathematics, this means, that instead of (14) the equation

$$F_\alpha(t_s) = \sum_{k=0}^{\infty} \frac{(\alpha)_k}{k!(k+1)!} \left(\frac{4r_s}{1-\alpha}\right)^k = 0 \qquad (38)$$

must be solved. It is seen that Equ. (38) can be fulfilled, even at ground state, only when α is negative which means, that $\varepsilon_0(r_s)$ is a function increasing monotonously. The "one electron spectrum" obtained from (38) — the analogy of Figures 1, 2 — is represented in Figure 5. In this case, only the last term of (36) is preserved, to which correction of the attraction of the Van der Waals forces should be applied. (It is negligible. [8])

Figure 4 includes the equation of state determined from (38), computed on the basis of $\varepsilon^1_{He}(r_s)$ as derived from $\alpha(r_s)$ of (38). The data of the dotted curve were calculated by the introduction of effective nuclear charge Z^* which account for the fact that one of the electrons screens the charge from the other [7]. At high densities, instead of Z^*/r the Yukawa potential should be used, and for this reason, at about 10^6 atmospheres the curve cannot be considered as reliable any more. The curve marked with triangles was

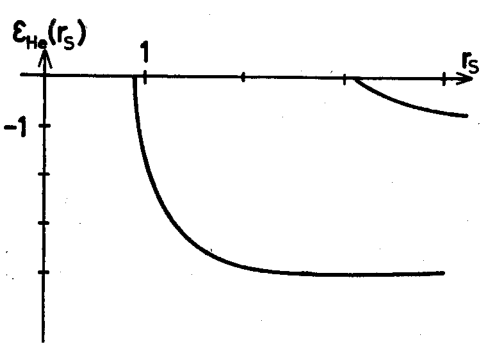

Figure 5

The quantities ε and r_s are given in ry and a_0 respectively. The curves represent the energy eigenvalue of the $1s$ and $2s$ states derived from (25). (With the function $\alpha(r_s)$ obtained from (38) Equ. (35) was computed and in the place of $\varepsilon_{He^+}(r_s)$ the numerical values of Figure 5 have been transposed.)

5. SUMMARY AND DISCUSSION

The results may be summerized as follows:

a) The modification of the spectra of hydrogen and He^+ ion at high pressures has been obtained. The equation of state of hydrogen for the temperature of $T = 0$ °K as well as the critical pressure of the evolution of metallic phase have been determined.

b) The equation of state of helium has been obtained for $T = 0$ °K. For astrophysical application the accuracy of the equation of state is satisfactory, as only the use of first order perturbation theory includes an error. The error in correlation energy is neglected, because it is only significant at low densities, where the Fermi gas model cannot be used anyway. At low pressures the equation of state resulting from the boundary condition $\varphi_0(r_s) = 0$ is apparently more realistic, though the condition that electron density is zero at the boundaries, applies only to free atoms. For more accurate calculations the boundary condition $\varphi_0(r_s) = \text{const}$ might be applied; the constant dependent on r_s would be close to zero, and much smaller than the value of $\varphi_0(r_s)$ in the case when boundary condition (22b) was applied. This means that inside the matter electron density $\varrho(r)$ is continuous, but it cannot be differentiated at point r_s.

c) Indications significant for geophysics have been gained relatively to pressure ionization and density jumps taking place in compressed matter.

The measurement of the modification of the hydrogen spectrum represented in Figures 1, 2 does not seem impracticable. Through a pressure of a few hundred atmospheres the region of $r_s \approx 10a_0$ can be reached. Here the gas must be kept at a temperature high enough to permit the observation of the spectrum of the hydrogen atom. A test performed to this effect would give precious information as regards the legitimacy of boundary condition (1).

Another possibility for the experimental verification is to measure the ionization energy of helium as a function of density; the theoretical value can be obtained from Fig. 2 and (25). (Then the value of (25) has to be calculated with $\alpha(r_s)$ from (38).)

The calculations of band width that would prove the well-foundedness of assumptions (22a) and (36) pass the frames of this paper, but their holding true at high pressures can hardly be contested.

In conclusion, the author would like to express his gratitude to Professors L. Detre, and L. Egyed, for having given possibility to perform this work, to Dr. D. Kisdi, and Dr. P. de Chatel, for many valueable advice and cristicism.

REFERENCES

[1] J. De Boer, J. Korringa, R. Kronig, Physica *12*, 245 (1946)
[2] E. Wigner, H. B. Hunington, J. of Chem. Phys. *3*, 764 (1938)
[3] D. Bohm, D. Pines, Phys. Rev. *92*, 609, *92*, 626 (1953)
[4] W. C. DeMarcus, A. J. *63* 2, (1958)
[5] W. C. DeMarcus, Univ. Liege Inst. Astrophys. Coll. 8° No. 448 (1963)
[6] S. Raimes, Phil. Mag. *43* 327 (1952)
[7] H. A. Bethe, E. E. Salpeter, Quantum Mechanics of One and Two Electron Systems. Hb. r. Physik Bd XXXVI. p. 232. Berlin, Springer (1957)
[8] L. Pauling, E. B. Wilson, Introduction to Quantum Mechanics, p. 383. New York and London, McGraw—Hill Book Company (1935)

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Akadémiai Nyomda, Budapest — Felelős vezető : Bernát György

A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
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MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST-SZABADSÁGHEGY

Nr. 63

B. SZEIDL

A STUDY OF SOME VARIABLE STARS IN MESSIER 3

BUDAPEST, 1973

A STUDY OF SOME VARIABLE STARS IN MESSIER 3

INTRODUCTION

A comprehensive study of the RR Lyrae type variables in the globular cluster Messier 3 was carried out some years ago.(SZEIDL,1965; In the following we refer to this work as PaperI.)In order to complete this investigation, all the known variable stars in Messier 3 which were left out of attention at the earlier study and could either be measured or be estimated on the plates of the Konkoly Observatory were investigated.

Generally the results of the present study are in accordance with those of Paper I.

OBSERVATIONS

The detailed description of the observational material can be found in Paper I. All the available observations of the different authors were also used: B=(BAILEY,1913), L=(LARINK,1922), M=(MÜLLER, 1933), S=(SLAVENAS,1929), G=(GREENSTEIN,1935), Ma=(MARTIN,1942) and RS=(ROBERTS and SANDAGE, 1955).Additional observations for some of the variables are mentioned in the remarks on individual variables.

The comparison stars were selected from SANDAGE's (1953) primary photoelectric and secondary photographic sequence.

The systematic errors of the magnitudes may be fairly high because most of the stars estimated are near the centre or have close companion.The following stars were estimated: Nos. 2, 3, 30, 111, 128, 130, 137, 144, 152, 166, 167, 177 and 178. The stars Nos. 95 and 141 furthermore SVS1264=v.Z.89 and SVS1276=v.Z.1221 were measured with the microphotometers of the Konkoly Observatory. The magnitudes obtained for the variables are given in Table 4.

The elaboration of the observational material and the determination of the epochs were carried out in the same way as in Paper I. Most of the periods were taken from SAWYER's (1955)catalogue and were improved.For each variable (except No.95) 20 normal points were formed from the Budapest material. The normal points are given in Table 3 and plotted against phase in Figure 2.

The results obtained for the RR Lyrae type variables: the period, the maximum, minimum and medial brightness, the amplitude, $\varepsilon = \frac{1}{P}(t_{max} - t_{min})$, the different parameters characterizing the O - C diagram

Table 1

No.	Period	M	m	med	A	ε	$10^{10}\beta$	c_1	c_2	c	B_{eff}	r
3	0.5582053	14.75	16.00	15.37	1.25	0.12	0.0	0	0	0		1.5
30	0.5120902	15.18	15.92	15.55	0.74	0.15	-	1	1	2	i?	1.1
111	0.5102469	15.06	16.02	15.54	0.96	0.16	-	5	3	8	i	1.5
128	0.2922710	15.40	15.86	15.63	0.46	0.44	-	3	3	6	i	2.9
130	0.5688172	15.27	16.00	15.63	0.73	0.23:	-	4	3	7	i	1.4
137	0.5751464	15.30	16.04	15.67	0.74	0.16	+0.3	1	-	1		0.9
144	0.5967843	15.27	15.99	15.63	0.72	0.16	-	≥2	≥3	≥5	i?	1.9
152	0.3261217	15.42	15.76	15.59	0.34	0.34:	-	-	-	-		1.5
167	0.6439839	15.62	16.00	15.81	0.38	0.17:	-	≥2	≥2	≥4		1.4
177	0.3483438	15.52	15.90	15.71	0.38	0.32	-	≥1	≥3	≥4		1.2
178	0.2650805	15.51	15.81	15.66	0.30	0.28:	-	-	-	-	i?	1.5
vZ89	0.6369126	15.74	16.51	16.12	0.77	0.21	-	-	-	-		18
vZ1221	0.5093832	15.38	16.60	15.99	1.22	0.12	-	-	-	-	i	28

(β, c_1, c_2 and c; see their explanation in Paper I), the indication of light curve variation or possible light curve variation and the distance of the variable from the centre of the cluster are summarized in Table 1.

REMARKS ON INDIVIDUAL VARIABLES

No.2 The star is near the centre of the cluster and has close companions. It is very difficult to estimate. No period has been found.

No.3 The period given by MARTIN satisfies all the observations. The variable has larger amplitude than it is expected from its period. The period-maximum, period-ε and amplitude-ε diagrams also suggest that the star belongs to the long period branch of the RRab stars on the period-amplitude diagram.

Although the O - C values are approximated by a straight line, small oscillations are real. This scatter can only be explained by supposing Blashko-effect, but the few maxima observed do not show any light curve variations.The O - C residuals have been computed with the formula:

$$C = 2425000.491 + 0^{d}.5582053 \times E$$

Observer	Year	t(med.) hel.	E	O - C
B	1895	2413372.516	-20831	$0^{d}.000$
	1897	14077.522:	-19568	-0.008:
	1898	14456.554	-18889	+0.003
L	1921	22761.531	- 4011	+0.001
M	1925	24285.427	- 1281	-0.003
G	1926	24647.700	- 632	-0.005
Ma	1940	29770.358	+ 8545	+0.003
Bp	1940	29775.390	+ 8554	+0.011
	1941	30078.494	+ 9097	+0.009
	1950	33420.466	+15084	+0.006
	1952	34121.563	+16340	-0.003
	1953	34487.180:	+16995	-0.010:
	1955	35223.451	+18314	-0.012
	1956	35600.263:	+18989	+0.012:
	1957	35933.504	+19586	+0.004
	1962	37791.183:	+22914	-0.024:

No.30 The error of the observations is fairly large because of the close companions. For this reason, the light elements are distorted (for example the light amplitude observed is too small). To all probability the star has light curve variation. The O - C oscillations of LARINK's epochs are very likely the result of the Blashko-effect. The O - C diagram has been constructed by using the formula:

$$C = 2425000.468 + 0^{d}.5120902 \times E$$

Observer	Year	t(med.) hel	E	O - C
B	1895	2413395.481:	-22662	$+0^{d}.001$:
	1897	14079.621:	-21326	-0.011:
	1898	14456.507:	-20590	-0.024:
L	1921	22733.454	- 4427	+0.009
		22761.634	- 4372	+0.024
M	1924	23858.516	- 2230	+0.009
	1925	24298.399	- 1371	+0.007
G	1926	24647.658:	- 689	+0.020:
Ma	1940	29770.08 :	+ 9314	+0.004:
Bp	1941	30078.351:	+ 9916	-0.003:
	1950	33390.544	+16384	-0.010
	1951	33763.331:	+17112	-0.025:
	1952	34126.430	+17821	+0.003
	1953	34487.434	+18526	-0.017
	1955	35223.332:	+19963	+0.007:
	1956	35603.309:	+20705	+0.013:
	1962	37791.467	+24978	+0.010

No.95 The observational material for the variable known to us can be found in the following publications: BAILEY (1913), GREENSTEIN (1935), RYBKA (1930), LARINK (1922), GUTHNICK (1933) and RUSSEV (1971).

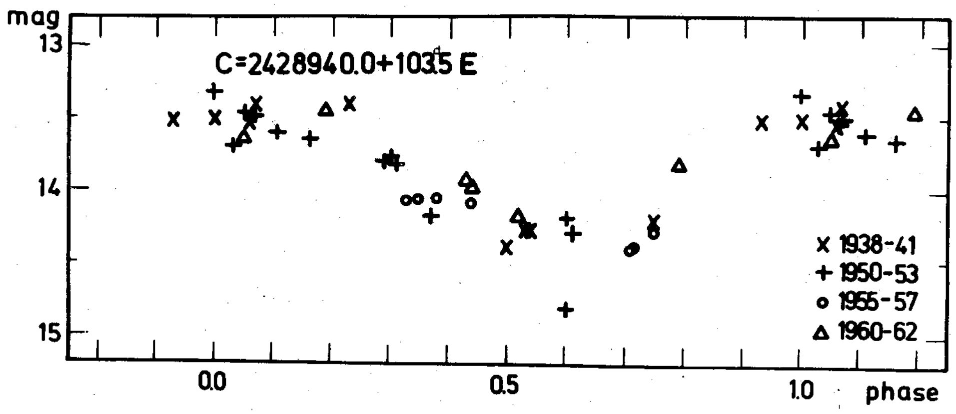

Figure 1 Light curve of No.95.

Table 2

J.D.	m	n	J.D.	m	n
2428963.5	13.40	1	2434126.4	13.60	1
991.5	14.39	5	131.4	13.64	1
29346.4	13.52	2	487.4	14.18	10
719.6	14.27	2	488.5	14.28	2
720.6	14.27	2	567.4	14.17	1
774.4	13.54	2	35223.5	14.40	10
775.4	13.42	4	224.5	14.38	10
30052.5	14.21	4	227.6	14.29	4
078.5	13.51	9	598.5	14.07	3
33390.5	13.31	6	600.4	14.06	7
420.5	13.79	8	603.4	14.06	11
421.5	13.76	7	920.5	14.09	7
422.5	13.82	6	36991.5	13.81	3
763.5	14.80	10	37018.6	13.62	10
34118.5	13.69	9	057.6	13.92	3
120.5	13.46	7	058.6	13.96	2
121.5	13.54	13	757.6	13.44	1
122.4	13.49	3	791.5	14.15	10

An attempt was made to transform all the observations into the same photographic system. For the colour index of the variable the mean value CI = $1^{m}.6$ was accepted. The greatest difficulty arose at BAILEY's observations. For estimating the brightness of the variable he used only the comparison stars a, c and d and, when No.95 was near maximum light he had to extrapolate. For this reason,his observations are systematically falsified.

The variable has a close, bright companion, therefore, the errors in the observations at Budapest may be considerable.

Our observations can be best satisfied with the period P = = $103^{d}.5$. No period could, however, be found which satisfied all the observations. LARINK's 1921 observations showed great discrepancy. Disregarding this, a slight increase of the period seems real.

For each night mean magnitudes were formed from the Budapest observations (Table 2) and were plotted against phase (Figure 2).

No.111 GREENSTEIN's period ($0^{d}.510$) is almost certainly well determined, although it is possible that the number of epochs in a year must be increased by one. (In this case P = $0^{d}.50948$.) While the 1926 observations could be satisfied by the accepted period, LARINK's observations on J.D.2422730 led to discrepancy. The light curve variation can clearly be seen from each observer's material. Both the height and the phase of maxima show strong variations.

The O - C diagram is very complicated. During the last 30 years the period decreased by $0^{d}.0001$. The O - C's have been obtained with the formula:

$$C = 2425000.070 + 0^{d}.5102469 \times E$$

Observer	Year	t (med.) hel.	E	O - C
B	1896	2413691.538:	-22163	$+0^{d}.070$:
	1897	14067.561:	-21426	+0.041:
	1900	15160.813	-19283	-0.166
L	1921	22756.581	- 4396	-0.444
M	1924	23858.503:	- 2237	-0.145:
	1925	24298.391	- 1375	-0.090
S	1926	24621.916	- 741	-0.061
		24642.823	- 700	-0.074
G	1926	24647.929	- 690	-0.071
Bp	1939	29346.231:	+ 8517	+0.388:
Ma	1940	29770.220	+ 9348	+0.362
Bp	1940	29775.285:	+ 9358	+0.325:
	1941	30078.339:	+ 9952	+0.292:
	1950	33390.619:	+16444	+0.049:
	1952	34131.435:	+17896	-0.014:
	1955	35223.293:	+20036	-0.084:
	1956	35603.380:	+20781	-0.131:
	1960	37018.569	+23555	-0.367
	1962	37791.514	+25070	-0.446

No.128 The large deviations in BAILEY's observations are very likely observational errors. The period is probably correct. From ROBERTS and SANDAGE's observations the light curve variation can be clearly seen, the oscillation of the phase of the medial brightness on the ascending branch amounts to $0^{d}.012$. The scatter in the Budapest

material is considerable.

The O - C diagram is fairly complicated. The curve drawn in seems to be the most likely although the groups of points might be shifted by P or its multiple parallel to the O - C axis. The O - C diagram is especially uncertain around J.D.2430000. The residuals have been derived by using the formula:

$$C = 2425000.018 + 0\overset{d}{.}2922710 \times E$$

Observer	Year	t(med.) hel.	E	O - C
B	1895	2413372.518:	-39784	+0$\overset{d}{.}$209:
	1896	13692.547:	-38689	+0.202:
	1897	14071.611:	-37392	+0.190:
	1900	15161.777	-33662	+0.185
L	1921	22761.575	- 7659	+0.061
M	1925	24285.427	- 2445	+0.012
G	1926	24683.786	- 1082	+0.005
Bp	1938	28991.578:	+13657	+0.015:
	1939	29346.234:	+14870	+0.146:
	1941	30078.406:	+17375	+0.179:
	1950	33420.497	+28810	+0.151
	1951	33763.350:	+29983	+0.171:
	1952	34118.452	+31198	+0.163
RS	1953	34447.860	+32325	+0.182
Bp	1953	34487.296:	+32460	+0.161:
	1955	35223.528	+34979	+0.163
	1956	35603.492	+36279	+0.174
	1957	35933.473	+37408	+0.181
	1962	37791.497	+43765	+0.239

No.130 BAILEY's best observations (in 1900) are very poor, the observations of 1895 - 1899 are completely unusable. No ascending branch was observed in 1900, the epoch given for that year is very uncertain.

The variable has strong light curve variation. The oscillation in the height of maxima amounts to 0$\overset{m}{.}$5. Unfortunately, the number of maxima well observed in the Budapest material is scarce, therefore the normal points were determined for the whole light curve.

The period accepted is probably correct, but P = 0$\overset{d}{.}$569665 (the number of epochs in a year is decreased by one) seems almost just as good. Contradiction seems to exist between MARTIN's epoch and the Budapest observations in the interval 1938 - 1941. The difference is about 0$\overset{d}{.}$03. It would be important to measure the plates of the Perkins Observatory obtained in 1939.

The O - C diagram is very complicated. On the average the period is decreasing. The scatter on the O - C diagram can probably be attributed to the Blashko-effect what we are not able to take into account.The O - C diagram is especially uncertain between BAILEY's and LARINK's observations. For this reason, the Mount Wilson Observatory's plates obtained in 1912 and 1915 would be very important to be measured. The O - C values have been obtained with the formula:

$$C = 2425000.370 + 0\overset{d}{.}5688172 \times E$$

Observer	Year	t(med.) hel.	E	O - C
B	1900	2415161.677:	-17296	-0.431:
L	1921	22729.613:	- 3992	-0.039:
		22761.453	- 3936	-0.053
M	1925	24286.486:	- 1255	-0.018:
		24290.450	- 1248	-0.036
		24298.418	- 1234	-0.032
		24311.509	- 1211	-0.023
G	1926	24647.685	- 620	-0.018
		24684.671:	- 555	-0.005:
Bp	1938	28991.252:	+ 7016	+0.061:
	1939	29346.201:	+ 7640	+0.068:
Ma	1940	29770.565	+ 8386	+0.094
Bp	1941	30078.270:	+ 8927	+0.069:
	1950	33420.521	+14803	-0.050
	1951	33763.475	+15406	-0.093
	1952	34118.342	+16030	-0.168
	1953	34487.523	+16679	-0.149
	1955	35223.463	+17973	-0.259
	1956	35603.435	+18641	-0.256
	1957	35933.245:	+19221	-0.360:
	1960	37018.471	+21129	-0.438
	1962	37791.483	+22488	-0.448

No.137 Only one epoch could be obtained from BAILEY's material (in 1900),nevertheless, the descending branches observed in other years (1895 - 1899) clearly showed that no essential O - C residuals existed compared with the O - C value in 1900. The scatter of MÜLLER's observations is large, therefore the epochs deduced from his material are very uncertain.

No doubt,the O - C diagram is a positive parabola, the scatter on it can be explained by the uncertain observations.The star lies very close to the centre of the cluster. The O - C diagram has been constructed by using the formula:

$$C = 2425000.352 + 0\overset{d}{.}5751464 \times E$$

Observer	Year	t(med.) hel.	E	O - C
B	1900	2415160.760	-17108	$+0\overset{d}{.}013$
M	1925	24289.464:	- 1236	-0.007:
G	1926	24647.792	- 613	+0.005
Bp	1940	29720.578:	+ 8207	-0.001:
	1941	30052.440	+ 8784	+0.002
	1950	33420.500	+14640	+0.005
	1951	33763.295:	+15236	+0.012:
	1953	34487.406	+16495	+0.014
	1956	35600.318:	+18430	+0.018:
	1960	37018.631:	+20896	+0.020:

No.141 = RV CVn = 4.1921 CVn was discovered by LARINK (1921). Its type and period was determined by SCHILT (1927). The star is of W UMa type and does not belong to the cluster.

Since the star lies near the edge of the photographic plates the error of the observations is fairly considerable. The following elements were deduced from the Budapest material:

$$\text{Min.I} = 15\overset{m}{.}97; \quad \text{Min.II} = 15\overset{m}{.}96 \text{ and Max.} = 14\overset{m}{.}98$$

Almost every observer who investigated the RR Lyrae type variables of the cluster also measured No.141. In addition to these observations Sc = SCHILT(1927), Ba = BAADE(1931) and Gr = GRAFF (1931) investigated this variable. GRAFF (1931) published only some epochs of the minimum from which a mean epoch was formed. GRAFF's (1923) observations obtained in 1921 were insufficient for determining an acceptable epoch. It would be interesting to complete the O - C diagram with observations before 1921. The O - C diagram has been constructed with the formula:

$$C = 2425000.032 + 0\overset{d}{.}2695671 \times E$$

Observer	Year	t(med.) hel.	E	O - C
L	1921	2422756.427	- 8323	$-0\overset{d}{.}002$
Sc	1926	24642.587	- 1326	+0.001
G	1926	24683.830	- 1173	0.000
Ba	1928	25326.478	+ 1211	0.000
Gr	1930	26177.770	+ 4369	-0.001
Bp	1938	28991.519	+14807	+0.007
	1940	29775.422	+17715	+0.009
	1941	30078.415	+18839	+0.008
	1950	33422.400	+31244	+0.014
	1951	33763.404	+32509	+0.015
	1952	34118.421	+33826	+0.012
	1953	34487.456	+35195	+0.010
	1955	35224.451	+37929	+0.008
	1956	35600.497	+39324	+0.008
	1957	35933.410	+40559	+0.006
	1960	37018.416	+44584	+0.004
	1962	37791.531	+47452	+0.001

No.144 The errors of the observations are large because of the close companion and dense surroundings. The period seems to be good. The variable probably has light curve variation, however, the large scatter prevents us from being sure of it. The epochs given in the table below are very uncertain. The material obtained for 1957 is especially poor.

The O - C diagram is fairly complicated, the period suddenly changed around J.D.2434500.The material before 1925 would be important for constructing a more complete O - C diagram. The O - C values have been computed by the formula:

$$C = 2425000.033 + 0\overset{d}{.}5967843 \times E$$

Observer	Year	t(med.) hel.	E	O - C
M	1925	2424284.503	- 1199	+0.014
G	1926	24647.940	- 590	+0.010
Ma	1940	29770.58 :	+ 7994	-0.147:
Bp	1940	29775.348:	+ 8002	-0.153:
	1941	30078.514	+ 8510	-0.153
	1950	33420.496	+14110	-0.163
	1952	34120.480	+15283	-0.207
	1953	34487.493	+15898	-0.217
	1955	35224.551	+17133	-0.187
	1956	35600.506	+17763	-0.207
	1960	37057.456	+20204	-0.007
	1962	37791.523	+21434	+0.015

<u>No.152</u> The error of the observations is very large bacause the variable cannot be separated from the object No.178 on most of the plates. GREENSTEIN's period ($0\overset{d}{.}32641$) may be right but the new period satisfies the observations better. The scatter on the O - C diagram is caused by observational errors. For the year 1938 the Budapest material provides the interval $-0\overset{d}{.}086 \leq O-C \leq -0\overset{d}{.}032$. Nothing can be said about possible light curve variation.

The residuals have been derived with the formula:

$$C = 2425000.280 + 0\overset{d}{.}3261217 \times E$$

Observer	Year	t(med.)hel	E	O - C
M	1925	2424298.469	- 2152	+0.003
G	1926	24647.728	- 1081	-0.014
Bp	1940	29720.551	+14474	-0.014
Ma	1940	29770.093:	+14626	-0.043:
Bp	1941	30078.297:	+15571	-0.024:
	1950	33421.397	+25822	+0.002
	1951	33763.515:	+26871	+0.019:
	1952	34121.556	+27969	-0.022
	1953	34487.467	+29091	-0.019
	1955	35223.514	+31348	-0.029
	1956	35600.519	+32504	-0.021
	1957	35920.468:	+33485	+0.003:
	1960	37018.490	+36852	-0.027
	1962	37791.436:	+39222	+0.011:

<u>No.166</u> The period is probably about $0\overset{d}{.}486$. The variable has strong light curve variation therefore the exact period could not be deduced from the poor material.

<u>No.167</u> According to the Budapest observations (especially J.D.2433420 and 422) GREENSTEIN's period is wrong. The new period satisfies all the observations except one point (J.D.2428963.487; m = = 16.18:) so it may also be wrong. Series of observations taken in the

same year are needed for determining the exact value of the period.

The O - C diagram is fairly complicated. On possible light curve variation nothing can be said. The O - C values have been obtained with the formula:

$$C = 2425000.288 + 0\overset{d}{.}6439839 \times E$$

Observer	Year	t(med.) hel.	E	O - C
M	1925	2424312.499	- 1068	$-0\overset{d}{.}014$
G	1926	24684.730	- 490	-0.006
Bp	1940	29775.471	+ 7415	+0.042
	1950	33420.469	+13075	+0.092
	1952	34122.401	+14165	+0.081
	1953	34487.526	+14732	+0.067
	1956	35603.506	+16465	+0.023
	1960	37018.328:	+18662	+0.012:
	1962	37757.611:	+19810	+0.002:

No.177 The variable has a close, bright companion therefore the light amplitude measured is systematically small. The error of epochs is considerable because of the large observational errors. According to GREENSTEIN's observations (these are the best) the light curve variation is unlikely.

The O - C diagram is typical for that of an RRc type star, however, one of the cycles may not be real. The O - C residuals have been derived by using the formula:

$$C = 2425000.068 + 0\overset{d}{.}3483438 \times E$$

Observer	Year	t(med.) hel.	E	O - C
M	1925	2424289.441	- 2040	$-0\overset{d}{.}006$
G	1926	24647.897	- 1011	+0.005
Bp	1938	28991.380:	+11458	-0.011:
	1940	29720.447:	+13551	-0.028:
	1941	30078.548	+14579	-0.024
	1950	33422.328:	+24178	+0.004:
	1952	34121.482	+26185	+0.032
	1953	34567.360	+27465	+0.030
	1955	35227.483:	+29360	+0.042:
	1956	35600.503	+30431	-0.015
	1960	37018.610	+34502	-0.016
	1962	37791.580:	+36721	-0.021:

No.178 The star is a difficult object having No.152 as its close companion. The variable is of RRc type with small amplitude. Perhaps it has light curve variation although the light amplitudes measured can also be different because of the considerable observational errors. The error of the epochs is also fairly large, it can exceed $0\overset{d}{.}01$. The period is certainly about $P \approx 0\overset{d}{.}265$. We could, however, not find a period which satisfied all the observations. The period probably

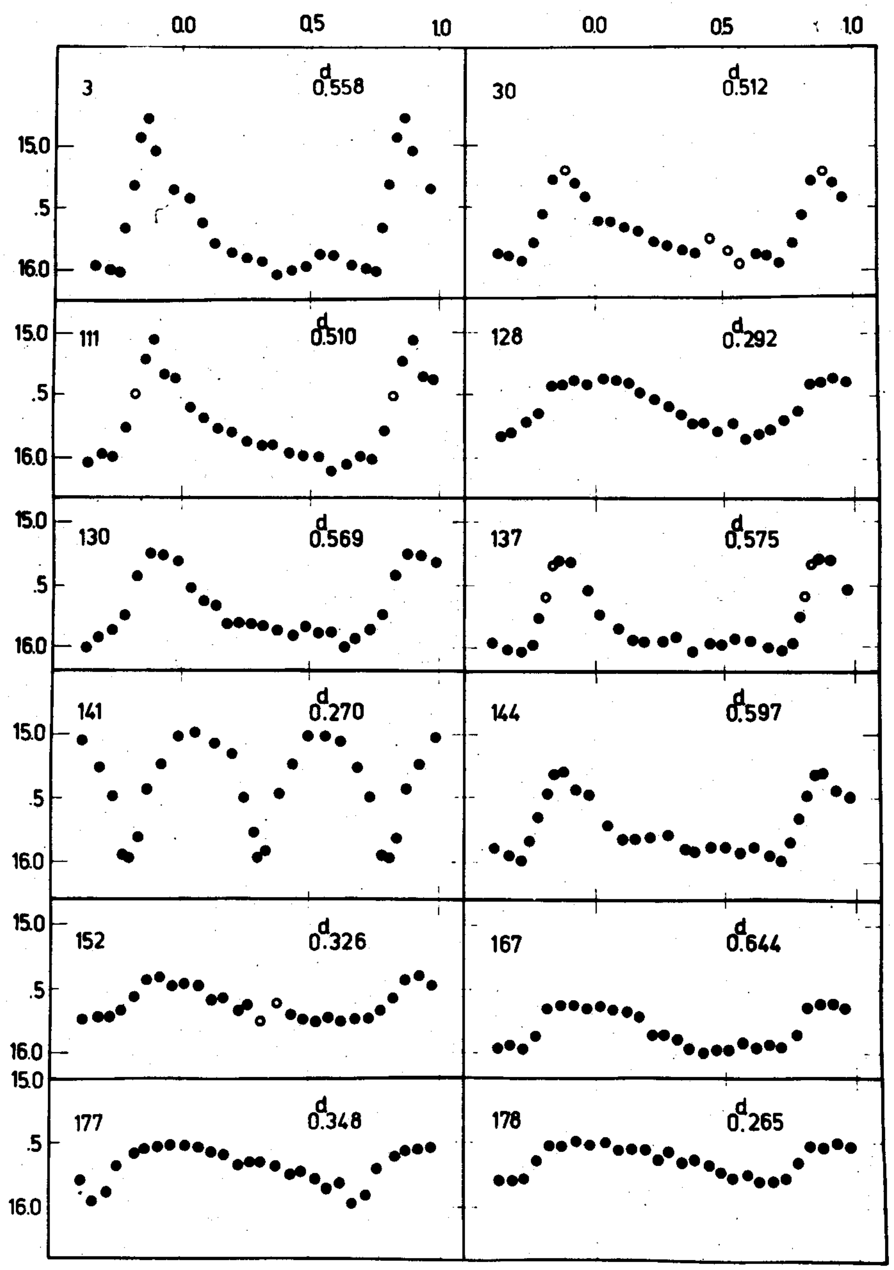

Fig. 2a Light curves of variables Nos. 3, 30, 111, 128, 130, 137, 141, 144, 152, 167, 177 and 178.

decreased by 10 sec between 1941 and 1950 and suddenly increased by about 10 sec around 1956. The O - C diagram has been constructed by using the formula:

$$C_1 = 2425000.050 + 0\overset{d}{.}2651549 \times E_1$$

for the interval 1925 - 1941 and

$$C = 2425000.050 + 0\overset{d}{.}2650805 \times E$$

for the years 1950 - 1962.

Observer	Year	t(med.) hel.	E	E_1	O - C	O - C_1
M	1925	2424286.500	- 2692	- 2691	$+0\overset{d}{.}047$	$+0\overset{d}{.}247$
G	1926	24647.942	- 1329	- 1328	+0.184	+0.283
Bp	1938	28991.429:	+15057	+15053	+0.062:	+0.267:
	1940	29774.426:	+18010	+18006	+0.276:	+0.262:
	1941	30078.543:	+19157	+19153	+0.346:	+0.246:
	1950	33422.494	+31772		+0.306	
	1951	33763.558:	+33059		+0.212:	
	1952	34120.578	+34406		+0.168	
	1953	34483.412	+35775		+0.107	
	1955	35224.467	+38571		-0.003	
	1956	35600.362	+39989		+0.008	
	1957	35933.562:	+41246		+0.002:	
	1960	37018.646:	+45339		+0.111:	
	1962	37791.551:	+48254		+0.307:	

I-I-42 Its Zeipel-number is 1390.The light amplitude of this variable is smaller than the error of our photographic observations. Its brightness is around $15\overset{m}{.}8$.

I-I-100 Its brightness is about $15\overset{m}{.}9$.The error of our photographic observations is larger than the amplitude of the light variation.

SVS 1264 The light variation of this star was discovered by KUROCHKIN (1959) and the star's Zeipel-number (v.z.89) was given by KUKARKIN (1960). The variable is situated far from the centre of the cluster (and from the centre of the photographic plates),therefore the photometric errors are large. The star was measured with both the Rosenberg and Becker-iris photometer of the Konkoly Observatory and mean values were formed.

The period given by KUROCHKIN seems to be right. The O - C diagram could only be constructed for the last 30 years from Ku = KUROCHKIN's (1961) observations and the material obtained at Budapest. The small oscillations in the O - C diagram appear to be real. This kind of oscillations in the O - C diagrams is generally characteristic of RRab variables with long period.The O - C values have been computed by using the formula:

$$C = 2435000.355 + 0\overset{d}{.}6369126 \times E$$

Observer	Year	t(med.) hel.	E	O - C
Bp	1941	2430078.300:	- 7728	+0^{d}.006:
	1950	33421.432	- 2479	-0.017
	1951	33763.463	- 1942	-0.008
	1952	34121.407	- 1380	-0.009
Ku	1953	34454.512:	- 857	-0.009:
Bp	1955	35224.553	+ 352	+0.005
	1956	35600.328	+ 942	+0.001
Ku		35602.244	+ 945	+0.007
Bp	1957	35933.446	+ 1465	+0.014
Ku	1959	36668.432	+ 2619	+0.003
Bp	1960	36991.340:	+ 3126	-0.004:
	1962	37791.318:	+ 4382	+0.012:

SVS 1276 The light variation of the star was discovered by KUROCHKIN (1959) and its Zeipel-number (v.Z.1221) was given by KUKARKIN (1961). The variable is far from the centre of the cluster (and far from the centre of the plates). The star can only be measured on the 9 × 12 cm plates and is not present on the 6 × 9 cm plates at all.

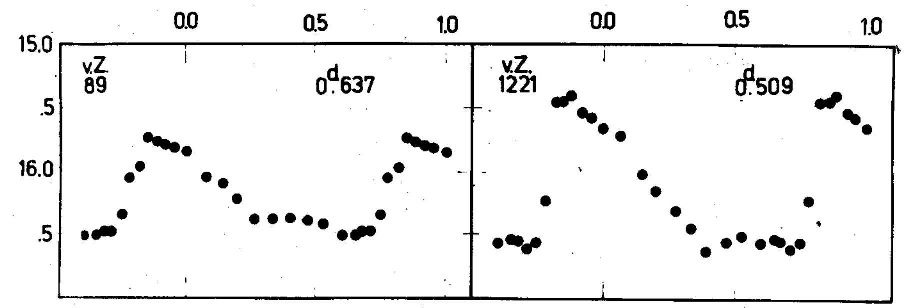

Fig. 2b Light curves of variables SVS 1264 = v.Z.89 and SVS 1276 = v.Z.1221

Although only a few well-observed maxima are available the Blashko-effect can be taken for certain. The period given by KUKARKIN and KUROCHKIN seems to be good. The O - C diagram has been constructed with the formula:

$$C = 2435000.317 + 0^{d}.5093832 \times E$$

Observer	Year	t(med.) hel.	E	O - C
Bp	1950	2433422.234:	- 3098	-0^{d}.014:
	1952	34121.147:	- 1726	+0.025:
	1953	34487.387	- 1007	+0.019
	1956	35603.421	+ 1184	-0.006
	1957	35933.500	+ 1832	-0.007
	1960	37018.495	+ 3962	+0.002
	1962	37791.234:	+ 5479	+0.006:

Table 3

PHASE		m - 10	n	PHASE		m - 10	n
No.3.				No.30.			
$0^{d}.005$	$0^{p}.009$	5.29	4	$0^{d}.004$	$0^{p}.008$	5.54	5
.020	.036	4.92	8	.022	.043	5.27	5
.038	.068	4.76	5	.046	.090	5.20	3
.054	.097	5.02	10	.065	.127	5.29	6
.092	.165	5.33	6	.084	.164	5.40	10
.125	.224	5.40	6	.110	.215	5.60	14
.155	.278	5.59	8	.135	.264	5.61	14
.182	.326	5.75	8	.163	.318	5.65	21
.218	.391	5.82	16	.190	.371	5.68	20
.250	.448	5.87	20	.220	.430	5.76	25
.285	.511	5.90	14	.248	.484	5.79	13
.314	.563	6.00	18	.278	.543	5.82	11
.350	.627	5.94	11	.304	.594	5.85	8
.380	.681	5.94	10	.332	.648	5.74	2
.412	.738	5.84	12	.370	.723	5.83	3
.441	.790	5.85	12	.392	.765	5.93	2
.480	.860	5.93	11	.426	.832	5.85	6
.513	.919	5.96	11	.447	.873	5.87	4
.535	.958	5.98	6	.471	.920	5.92	4
.548	.982	5.63	7	.497	.971	5.77	4
No.111.				No.128.			
$0^{d}.011$	$0^{p}.022$	5.49	2	$0^{d}.010$	$0^{p}.034$	5.45	11
.030	.059	5.21	4	.022	.075	5.44	5
.049	.096	5.05	5	.035	.120	5.41	6
.069	.135	5.33	6	.050	.171	5.44	7
.089	.174	5.36	5	.067	.229	5.40	13
.119	.233	5.59	7	.082	.281	5.41	11
.147	.288	5.67	17	.096	.328	5.43	11
.175	.343	5.76	14	.108	.370	5.50	13
.202	.396	5.79	18	.125	.428	5.56	13
.231	.453	5.86	19	.141	.482	5.62	8
.261	.512	5.89	18	.155	.530	5.68	10
.285	.559	5.88	17	.168	.575	5.76	7
.316	.619	5.94	13	.181	.619	5.75	8
.344	.674	5.96	8	.197	.674	5.82	7
.373	.731	5.97	14	.214	.732	5.76	9
.399	.782	6.08	11	.228	.780	5.88	10
.429	.841	6.02	10	.245	.838	5.84	7
.457	.896	5.96	13	.256	.876	5.81	5
.479	.939	5.98	7	.272	.931	5.73	9
.503	.986	5.76	4	.288	.985	5.66	7

Table 3 (continued)

No.130.

PHASE		m - 10	n
$0^{d}.015$	$0^{P}.026$	5.44	9
.042	.074	5.28	10
.072	.127	5.29	7
.103	.181	5.34	8
.132	.232	5.54	6
.160	.281	5.64	7
.188	.331	5.68	10
.212	.373	5.82	12
.239	.420	5.81	9
.267	.469	5.82	6
.293	.515	5.83	9
.324	.570	5.87	7
.357	.628	5.91	11
.385	.677	5.84	11
.412	.724	5.89	10
.443	.779	5.88	11
.470	.826	6.00	13
.497	.874	5.93	14
.528	.928	5.86	16
.556	.977	5.75	15

No.137.

PHASE		m - 10	n
$0^{d}.005$	$0^{P}.009$	5.61	2
.020	.035	5.37	3
.035	.061	5.33	4
.061	.106	5.34	11
.099	.172	5.56	10
.124	.216	5.74	10
.167	.290	5.84	6
.198	.344	5.94	13
.224	.389	5.96	17
.264	.459	5.96	7
.291	.506	5.93	7
.330	.574	6.04	11
.368	.640	5.98	9
.394	.685	5.99	13
.425	.739	5.94	9
.460	.800	5.96	9
.496	.862	6.01	14
.525	.913	6.03	9
.552	.960	5.98	8
.567	.986	5.77	3

No.141.

PHASE		m - 10	n
$0^{d}.001$	$0^{P}.004$	5.96	16
.009	.033	5.80	4
.019	.070	5.42	9
.032	.119	5.23	16
.050	.185	5.01	14
.067	.249	4.98	15
.088	.326	5.06	14
.106	.393	5.15	13
.118	.438	5.48	11
.129	.479	5.76	8
.134	.497	5.95	5
.143	.530	5.90	4
.154	.571	5.45	6
.168	.623	5.22	15
.186	.690	5.01	13
.203	.753	5.00	17
.220	.816	5.04	15
.238	.883	5.25	11
.251	.931	5.48	5
.262	.972	5.94	8

No.144.

PHASE		m - 10	n
$0^{d}.014$	$0^{P}.023$	5.47	8
.031	.052	5.31	8
.051	.085	5.29	4
.079	.132	5.43	12
.112	.188	5.47	8
.151	.253	5.70	7
.185	.310	5.81	5
.215	.360	5.81	7
.248	.416	5.79	7
.291	.488	5.77	5
.329	.551	5.88	4
.350	.586	5.90	8
.389	.652	5.87	12
.422	.707	5.87	13
.457	.766	5.92	19
.489	.819	5.87	18
.524	.878	5.94	20
.550	.922	5.98	7
.571	.957	5.83	6
.591	.990	5.64	14

Table 3 (continued)

PHASE		m − 10	n	PHASE		m − 10	n
No.152.				No.167.			
$0^{d}.008$	$0^{P}.025$	5.58	13	$0^{d}.016$	$0^{P}.025$	5.66	8
.023	.071	5.44	13	.050	.078	5.63	6
.041	.126	5.41	10	.083	.129	5.63	10
.057	.175	5.48	12	.112	.174	5.66	12
.072	.221	5.46	13	.147	.228	5.64	9
.091	.279	5.48	11	.177	.275	5.67	7
.107	.328	5.59	10	.214	.332	5.69	4
.120	.368	5.58	7	.244	.379	5.73	6
.139	.426	5.67	6	.276	.429	5.87	9
.151	.463	5.63	5	.304	.472	5.87	10
.168	.515	5.75	3	.338	.525	5.91	17
.189	.580	5.61	3	.370	.575	5.98	18
.206	.632	5.70	7	.400	.621	6.01	8
.222	.681	5.74	10	.435	.675	5.99	13
.237	.727	5.76	10	.467	.725	5.99	9
.254	.779	5.73	16	.500	.776	5.93	8
.269	.825	5.75	10	.536	.832	5.97	9
.288	.883	5.73	12	.566	.879	5.95	12
.304	.932	5.72	11	.597	.927	5.97	16
.319	.978	5.67	18	.633	.983	5.87	16
No.177.				No.178.			
$0^{d}.011$	$0^{P}.032$	5.60	9	$0^{d}.005$	$0^{P}.019$	5.53	9
.026	.075	5.56	8	.018	.068	5.54	9
.042	.121	5.55	9	.032	.121	5.50	9
.060	.172	5.53	8	.046	.174	5.53	9
.077	.221	5.54	9	.061	.230	5.51	12
.097	.278	5.55	14	.075	.283	5.57	8
.115	.330	5.58	10	.088	.332	5.56	8
.130	.373	5.60	12	.102	.385	5.56	11
.149	.428	5.68	13	.115	.434	5.64	7
.166	.477	5.65	12	.126	.475	5.57	10
.182	.522	5.65	7	.139	.525	5.66	11
.201	.577	5.68	15	.152	.574	5.64	13
.220	.632	5.75	11	.167	.630	5.68	10
.234	.672	5.73	11	.179	.675	5.73	12
.254	.729	5.78	14	.191	.721	5.78	11
.269	.772	5.85	5	.207	.781	5.75	8
.286	.821	5.81	9	.218	.823	5.80	11
.304	.873	5.97	4	.232	.876	5.80	9
.322	.924	5.90	4	.244	.921	5.78	12
.336	.965	5.70	6	.257	.970	5.65	9

Table 3 (continued)

PHASE		m - 10	n	PHASE		m - 10	n
v.Z.89.				v.Z.1221.			
$0^{d}.011$	$0^{p}.017$	5.97	8	$0^{d}.010$	$0^{p}.020$	5.47	4
.030	.047	5.74	7	.023	.045	5.47	3
.053	.083	5.77	6	.040	.079	5.42	7
.074	.116	5.80	4	.061	.120	5.55	4
.096	.151	5.82	10	.077	.151	5.59	3
.126	.198	5.85	15	.100	.196	5.67	2
.172	.270	6.05	12	.135	.265	5.73	4
.214	.336	6.10	11	.175	.344	6.03	4
.251	.394	6.23	13	.203	.399	6.16	11
.296	.465	6.38	17	.241	.473	6.31	19
.338	.531	6.37	17	.272	.534	6.44	17
.382	.600	6.37	12	.301	.591	6.62	13
.425	.667	6.40	14	.341	.669	6.55	10
.464	.729	6.41	12	.370	.726	6.50	11
.510	.801	6.51	8	.408	.801	6.56	12
.542	.851	6.50	4	.434	.852	6.53	2
.561	.881	6.47	8	.446	.876	6.54	4
.580	.911	6.47	4	.464	.911	6.60	8
.605	.950	6.34	7	.483	.948	6.55	4
.624	.980	6.05	7	.500	.982	6.23	8

OBSERVATIONS OF VARIABLES.(m-10) Table 4

J.D. 24...	2	3	30	95	111	128	130	137
28963.487	6.04	6.10	6.10	3.40	6.27	5.77	5.77	6.37
28991.403	5.96	5.97	5.87	4.40	6.23	5.62	5.67	5.67
.416	6.05	6.03	5.92	4.41	6.20	5.53	5.53	5.87
.430	5.98	6.07	5.93	4.40	6.13	5.63	5.60	5.93
.522	5.98	6.12	6.03	4.36	6.20	5.87	5.93	6.13
.542	5.89	6.03	5.87	4.36	6.10	5.82	5.87	5.97
29346.376	5.69	5.70	5.97	3.58	5.63	5.68	5.67	5.87
.392	5.78	5.95	5.80	3.47	5.87	5.65	5.73	5.87
29719.549	5.82	5.95	5.77	4.26	6.07	5.60	5.87	5.90
.560	5.90	5.70	5.72	4.28	6.17	5.62	6.03	6.00
29720.546	5.84	5.68	5.63	4.34	6.00	5.65	5.62	6.07
.558	5.78	5.77	5.40	4.20	5.97	-	5.70	5.95
29774.405	5.89	5.70	5.97	3.51	5.72	5.37	6.20	6.23
.417	5.90	5.80	5.83	3.58	5.63	-	6.10	6.15
29775.403	5.76	4.97	5.80	3.46	5.63	5.43	6.00	5.93
.415	5.75	4.73	5.80	3.48	5.75	5.65	5.87	5.95
.426	5.80	4.73	5.87	3.31	5.83	-	6.03	5.97
.437	5.75	5.03	5.90	-	5.72	5.60	6.07	6.03
.447	5.82	5.15	5.75	3.43	5.73	-	6.07	6.00
30052.462	5.82	5.80	5.83	4.24	5.58	5.37	5.92	5.40
.474	5.78	5.80	5.73	4.22	5.53	5.23	5.93	5.43
.489	5.85	5.87	5.70	4.17	5.50	5.27	5.87	5.32
.501	5.75	5.93	5.75	4.22	5.67	5.40	5.80	5.40
30078.418	5.74	5.83	5.30	3.45	5.58	5.30	5.62	5.68
.434	5.70	5.97	5.43	3.42	5.63	5.30	5.63	5.63
.470	5.68	5.97	5.67	3.53	5.65	5.37	5.85	5.67
.483	5.63	5.53	5.65	3.53	5.65	5.27	5.75	-
.498	5.79	5.28	5.68	3.54	5.75	5.40	5.80	5.80
.509	5.80	4.97	5.65	3.56	5.90	5.37	5.90	5.80
.521	5.81	4.68	5.63	3.53	5.87	5.53	5.90	6.03
.536	5.70	4.72	5.63	3.53	5.70	5.52	5.87	5.93
.548	5.76	4.80	5.52	3.51	5.77	5.43	5.88	5.90
33390.497	5.88	5.70	5.83	3.36	6.00	5.53	5.62	5.90
.534	5.80	5.87	5.77	3.35	6.17	5.70	5.70	6.03
.545	5.79	5.83	5.55	3.26	6.13	5.77	5.63	6.10
.558	5.75	5.80	5.20	3.33	6.07	5.80	5.70	-
.570	5.82	5.97	5.27	3.30	6.00	5.70	5.77	5.93
.586	5.82	5.90	5.30	3.23	6.17	5.90	5.80	5.97
33420.424	5.85	6.13	5.65	3.74	6.07	6.00	6.17	6.05
.438	5.94	6.13	5.75	3.84	6.05	5.87	5.88	6.20
.450	5.92	5.73	5.87	3.76	6.10	5.80	5.97	6.07
.476	5.73	5.13	5.80	3.81	5.97	5.83	5.90	6.03
.487	5.76	4.98	5.80	3.71	6.07	5.67	5.75	5.90
.498	5.70	4.80	5.80	3.80	5.97	5.67	5.80	5.60
.510	5.66	5.10	5.68	3.84	5.97	5.40	5.88	5.50
.523	5.65	4.97	5.68	3.84	6.00	5.40	5.77	5.32
33421.385	5.74	5.93	5.70	-	5.72	5.53	5.80	5.85
.442	5.70	5.90	5.53	3.74	5.65	5.53	5.77	5.90
.454	5.77	6.00	5.63	3.75	5.85	5.50	5.85	5.97
.465	5.64	5.87	-	3.77	5.70	5.50	5.83	5.90
.475	5.68	5.80	-	3.88	5.73	5.50	5.77	5.90
.486	5.72	5.80	-	3.77	5.73	5.53	5.85	5.80
.497	5.69	5.90	5.60	-	5.78	5.53	5.80	6.00
.535	5.69	6.00	5.72	3.71	5.83	-	5.88	5.75
.548	5.73	-	6.00	3.69	5.80	5.90	6.00	-
33422.398	5.81	6.03	5.73	3.81	5.90	5.80	5.90	5.90
.431	5.70	5.93	5.57	3.71	5.92	5.95	5.77	5.90
.442	5.97	6.17	5.97	3.88	6.12	6.07	5.80	6.00

Table 4 (continued)

J.D. 24...	2	3	30	95	111	128	130	137
33422.452	5.97	6.08	5.77	-	6.03	6.00	5.90	5.97
.462	-	-	-	-	-	-	-	-
.472	5.78	6.13	5.77	3.85	6.07	6.07	5.80	6.00
.483	5.97	6.07	5.62	-	6.13	6.13	5.80	6.03
.493	5.72	6.03	5.80	3.86	5.97	6.07	5.63	6.10
.508	5.71	5.97	5.67	3.83	6.00	5.73	5.80	5.78
.520	5.65	6.07	5.72	-	5.90	5.70	5.75	6.10
33763.406	5.80	5.90	5.43	4.75	6.17	5.10	6.03	5.70
.420	5.80	5.65	5.43	4.73	5.90	5.40	6.07	5.60
.442	5.75	5.80	5.57	4.81	6.03	5.47	5.92	5.65
.455	5.84	6.03	5.80	4.78	6.07	5.52	5.90	5.93
.464	5.82	5.93	5.75	4.82	6.13	5.58	5.80	6.03
.483	5.80	5.97	5.73	4.89	6.17	5.55	5.35	5.97
.494	5.80	5.97	5.72	4.82	5.97	5.60	5.17	5.93
.504	5.85	6.10	5.90	4.79	6.07	5.75	5.38	6.07
.514	5.90	5.97	5.92	4.85	6.03	5.65	5.50	6.00
.525	5.92	6.13	5.80	4.78	6.13	5.68	5.57	-
34118.355	5.68	5.62	5.63	3.69	5.85	5.60	5.43	6.05
.372	5.76	5.50	5.73	3.69	5.70	5.70	5.22	5.95
.388	5.66	5.53	5.65	-	5.72	5.67	4.97	-
.428	5.82	5.90	5.87	3.79	5.90	5.80	5.23	6.03
.443	5.78	5.93	5.87	3.65	5.83	5.87	5.47	6.03
.470	5.74	5.60	5.80	3.72	5.85	5.50	5.45	-
.485	5.78	6.03	6.00	3.68	6.03	5.63	5.58	6.00
.499	5.80	5.80	5.80	3.60	5.90	-	5.68	6.10
.513	5.88	5.83	6.10	3.73	5.93	-	5.70	6.17
.526	5.66	5.80	5.90	-	6.00	5.53	5.72	-
.540	5.82	5.97	5.93	3.71	5.97	5.47	5.87	6.00
34120.471	5.76	4.80	-	3.47	5.83	-	5.73	-
.484	5.83	4.80	5.50	3.48	5.80	5.47	5.97	-
.497	5.70	5.03	5.57	3.38	5.83	5.62	5.80	-
.510	5.79	5.30	5.80	-	5.90	5.53	6.07	5.43
.523	5.73	5.35	5.60	3.42	6.07	5.45	5.90	5.60
.536	5.70	5.20	5.73	3.46	5.97	5.30	6.00	5.70
.551	5.82	5.63	5.93	3.43	6.00	5.40	5.97	5.80
.564	5.81	5.30	5.65	-	5.90	5.33	5.93	5.67
.579	5.82	5.30	5.80	3.55	5.93	5.20	5.87	5.65
34121.401	5.75	5.80	5.60	3.52	5.70	5.40	5.80	-
.412	5.66	5.80	5.60	3.49	5.67	5.45	5.72	6.00
.422	5.72	5.73	5.73	3.50	5.67	5.47	5.72	6.00
.431	5.68	5.70	5.50	3.51	5.73	5.37	5.77	6.10
.441	5.66	5.80	5.63	3.58	5.68	5.47	5.82	6.05
.484	5.71	5.93	5.75	3.54	5.88	5.73	5.87	6.07
.495	5.81	6.03	5.70	3.47	5.93	5.58	5.83	6.03
.505	5.70	5.90	5.77	3.57	5.77	5.68	5.90	5.97
.517	5.82	6.03	5.90	3.49	5.87	5.70	5.93	6.00
.528	5.77	5.93	5.70	-	5.85	5.63	5.93	6.00
.539	5.80	5.93	5.80	3.60	5.95	5.75	5.95	6.10
.552	5.77	5.60	5.77	3.61	5.83	-	5.93	-
.562	5.84	5.45	-	3.60	5.70	-	5.93	-
.594	5.80	-	5.75	3.55	5.83	5.97	5.78	-
.605	5.85	4.80	5.97	-	6.03	5.90	6.10	-
34122.404	5.66	5.60	-	3.50	5.63	5.80	5.30	-
.416	5.70	5.80	5.50	3.53	5.68	5.60	5.40	6.00
.431	5.72	5.73	-	3.44	5.77	5.77	5.50	-
34126.433	5.68	5.82	5.50	3.60	5.57	5.57	5.58	5.87
34131.415	5.64	5.73	5.97	3.64	5.85	5.63	5.60	-
34487.347	5.73	5.65	5.85	4.15	6.00	5.47	5.75	6.00

Table 4 (continued)

J.D. 24...	2	3	30	95	111	128	130	137
34487.367	5.76	-	6.00	4.17	6.13	5.37	6.00	6.03
.385	5.84	5.63	6.00	4.15	6.20	5.52	6.00	6.10
.397	5.75	5.80	5.93	-	6.13	5.40	5.88	5.75
.410	5.66	5.73	6.00	-	6.00	5.58	6.03	5.72
.428	5.77	5.87	5.43	-	6.17	5.57	5.97	5.38
.438	5.72	6.00	5.50	4.23	6.03	5.65	6.02	5.33
.449	5.70	5.80	5.33	4.20	6.13	5.77	5.92	5.35
.460	5.69	5.83	5.07	4.13	6.13	5.70	6.03	5.18
.474	5.70	5.90	5.12	4.15	6.17	-	6.07	5.33
.483	5.60	5.93	5.18	4.24	6.00	5.80	5.83	5.30
.494	5.61	6.00	5.08	4.18	5.93	5.65	5.87	5.17
.508	5.66	6.10	5.17	-	6.00	5.65	5.78	5.45
.518	5.71	5.90	5.18	4.19	6.07	5.72	5.78	5.40
34488.530	5.75	5.90	5.30	4.30	5.90	5.43	5.83	5.95
.540	5.79	6.00	5.37	4.25	5.90	5.43	5.93	6.00
34567.388	5.60	5.93	5.12	4.17	5.77	5.40	5.72	5.23
35223.415	5.59	5.90	5.45	4.33	5.60	5.75	5.90	6.00
.428	5.61	5.87	5.45	4.33	5.63	-	5.90	5.95
.441	5.66	5.53	5.53	4.36	5.73	5.63	5.68	5.95
.467	5.69	5.10	5.43	4.47	5.63	5.90	5.57	5.93
.490	5.65	4.77	-	4.38	5.77	5.70	5.55	6.00
.503	5.66	5.03	-	4.42	5.82	5.85	5.37	5.95
.517	5.67	4.97	-	4.41	5.72	5.67	5.33	5.90
.530	5.67	5.13	-	4.40	5.77	5.60	5.20	6.00
.546	5.58	5.15	-	4.46	5.75	5.50	5.42	-
.573	5.65	5.23	-	4.40	5.87	5.37	5.37	-
35224.454	5.58	5.80	5.58	4.36	5.80	5.52	5.68	5.87
.472	5.64	5.93	5.43	4.41	5.72	5.40	5.78	6.00
.485	5.65	6.00	5.65	4.45	5.73	5.60	5.90	6.00
.499	5.69	6.00	5.52	4.39	5.73	5.17	5.82	5.93
.512	5.58	6.00	5.57	4.39	5.77	5.37	5.87	6.03
.524	5.53	5.90	5.58	4.46	5.78	-	5.73	5.83
.542	5.62	6.00	5.58	4.34	5.73	-	5.80	5.75
.556	5.61	5.60	5.72	4.31	6.00	-	5.78	6.05
.569	5.69	5.27	-	4.37	5.68	-	5.62	-
.583	5.65	5.10	5.78	4.34	5.83	-	-	-
35227.534	5.53	5.87	-	4.33	5.70	5.90	5.32	6.00
.547	5.56	5.80	-	4.25	5.95	5.72	5.07	-
.560	5.58	5.77	-	4.33	5.80	5.80	5.43	5.97
.573	5.55	5.83	-	4.25	5.93	5.77	5.37	-
.586	5.69	5.67	-	-	5.90	5.90	5.70	6.00
35598.507	5.68	6.00	5.67	4.10	6.00	5.87	5.60	6.00
.524	5.69	6.00	5.80	4.02	5.82	5.62	5.73	6.00
.537	5.63	6.00	5.72	4.10	5.97	5.47	5.83	6.00
35600.363	5.69	5.52	5.37	4.08	5.03	5.43	5.83	5.03
.378	5.58	5.43	5.53	-	5.12	5.42	5.92	5.17
.391	5.68	5.43	5.52	4.09	5.33	5.47	5.80	5.33
.405	5.60	5.55	5.70	4.09	5.28	5.65	5.73	5.40
.421	5.60	5.55	5.58	4.04	5.57	5.63	5.75	5.62
.434	5.74	5.60	5.72	-	5.50	5.60	5.90	5.58
.446	5.63	5.62	5.83	4.08	5.53	-	5.90	5.50
.501	5.61	5.60	5.93	4.03	5.68	5.70	5.83	-
.525	5.60	5.90	5.62	3.98	5.88	5.83	5.77	-
35603.369	5.70	5.97	5.33	4.13	5.68	5.70	5.90	5.75
.381	5.80	6.00	5.37	4.02	5.55	-	5.93	-
.397	5.69	5.87	5.37	4.01	5.12	-	5.83	5.80
.408	5.70	5.85	5.50	4.05	5.00	5.60	5.68	6.00
.419	5.71	6.00	5.50	4.05	5.03	5.85	5.80	5.77

Table 4 (continued)

J.D. 24...	2	3	30	95	111	128	130	137
35603.431	5.76	6.00	5.68	4.13	5.23	-	5.85	5.93
.446	5.70	5.90	5.53	4.06	5.30	5.80	5.52	5.85
.457	5.70	5.80	5.53	4.11	5.20	-	5.60	5.90
.468	5.74	5.93	5.50	4.03	5.35	5.72	5.50	5.90
.491	5.64	5.90	5.57	4.03	5.45	5.62	5.43	5.87
.507	5.72	5.93	5.72	4.09	5.52	5.47	5.43	6.00
35920.444	5.82	6.03	-	4.05	5.82	5.43	-	6.00
.467	5.82	-	-	4.13	5.75	-	6.00	-
.487	5.58	5.68	5.50	4.15	5.90	5.43	5.90	5.87
.504	-	6.00	-	4.00	5.60	-	5.97	-
.547	-	6.00	-	4.07	5.93	-	5.93	6.00
.562	-	5.97	-	4.12	5.90	-	5.97	-
.585	-	5.93	-	4.14	-	-	5.78	-
35933.415	5.76	5.70	5.62	-	5.43	5.85	5.68	5.60
.443	5.70	6.00	-	-	5.53	6.00	5.80	-
.479	5.84	6.10	5.80	-	5.70	5.57	5.73	5.65
.503	-	-	-	-	-	-	-	-
.515	-	5.00	-	-	-	-	6.00	-
.530	-	4.77	-	-	5.20	-	5.85	-
.543	-	-	-	-	-	-	-	-
.573	-	5.30	-	-	5.25	-	5.80	-
.588	-	-	-	-	-	-	-	-
.602	-	-	-	-	-	-	-	-
36991.457	5.53	5.45	5.90	3.81	-	-	5.68	5.80
.470	-	-	-	3.81	5.80	-	5.90	-
.485	5.60	-	-	3.82	-	-	5.70	-
37018.470	-	5.80	5.80	3.62	5.77	5.40	5.65	5.90
.483	5.58	5.78	-	3.69	5.83	5.37	5.43	5.93
.496	5.67	5.87	5.60	3.64	5.80	5.27	5.10	5.95
.510	5.63	-	-	-	5.65	5.30	5.03	-
.523	5.60	5.77	-	3.53	5.80	5.33	4.97	-
.537	5.66	5.77	-	3.66	5.83	5.35	5.20	-
.550	5.60	5.70	-	3.65	-	-	5.13	-
.563	-	-	-	-	-	-	-	-
.577	5.69	5.83	-	3.54	5.43	-	5.27	-
.609	5.68	5.80	-	3.60	4.93	-	5.50	5.97
.623	-	-	-	3.62	-	-	-	-
.637	-	5.70	-	3.65	5.30	-	5.60	-
37057.539	5.65	5.97	5.65	3.84	5.73	-	5.77	5.80
.552	5.69	5.97	5.77	3.99	5.77	-	6.00	5.93
.578	5.70	5.97	5.68	3.92	5.63	5.30	5.97	5.90
37058.529	5.70	5.90	5.97	3.96	5.93	5.57	5.97	5.97
.580	5.85	5.93	5.93	3.97	5.93	5.68	5.90	5.93
37757.598	-	-	-	3.44	5.65	-	-	-
37791.365	5.82	5.85	5.83	4.23	5.90	5.72	5.97	6.03
.380	5.90	5.75	5.87	4.11	5.87	5.80	5.97	6.00
.394	5.97	5.87	5.87	4.13	6.07	5.72	6.07	6.00
.424	5.93	5.90	5.93	-	5.93	-	6.00	6.00
.439	5.80	5.83	5.67	-	5.97	5.90	5.87	6.13
.454	5.78	5.90	5.63	4.10	5.87	-	5.83	6.03
.469	5.95	6.00	5.73	-	6.00	5.93	5.75	6.03
.483	5.83	5.97	5.50	4.15	5.70	5.63	5.53	6.03
.497	5.85	6.00	-	4.12	5.80	5.65	5.68	6.03
.519	5.79	5.97	-	4.23	5.50	5.47	5.30	5.97
.533	5.79	6.00	5.40	4.18	5.23	5.40	5.43	6.00
.549	5.73	6.00	5.50	4.19	5.23	5.47	5.55	6.03
.563	5.65	5.97	5.57	4.10	5.47	5.47	5.40	5.97

Table 4 (continued)

J.D. 24...	141	144	152	166	167	177	178	V.Z. 89	V.Z. 1221
28963.487	5.78	6.07	5.97	5.98	6.18	-	5.78	6.47	6.59
28991.403	5.60	5.68	5.62	6.12	6.07	5.73	5.80	6.48	6.67
.416	5.11	5.93	5.67	6.07	6.08	5.70	5.80	6.31	6.33
.430	4.92	5.90	5.67	6.00	6.13	5.97	5.65	6.32	6.51
.522	5.66	6.10	5.83	5.63	6.17	-	5.65	6.50	6.62
.542	5.10	5.87	5.87	5.50	6.03	5.77	5.60	6.43	6.66
29346.376	5.05	5.32	5.73	5.97	5.95	5.50	5.70	6.33	6.66
.392	5.47	5.27	5.80	5.93	5.95	5.47	5.80	6.55	6.70
29719.549	4.98	5.80	5.80	5.57	5.77	5.77	5.78	6.20	6.52
.560	4.91	5.70	5.77	5.50	5.77	5.83	5.90	-	6.36
29720.546	5.33	5.57	5.58	5.63	6.00	5.77	5.70	-	6.42
.558	5.64	5.35	5.60	5.48	6.00	5.75	5.68	-	6.34
29774.405	4.80	5.67	5.68	5.68	5.83	6.10	5.83	6.35	6.35
.417	4.93	5.63	5.53	5.77	5.75	6.10	5.70	6.13	-
29775.403	5.26	5.20	5.50	5.93	5.87	5.93	5.82	6.13	6.06
.415	5.68	5.50	5.57	5.97	6.03	5.97	5.83	6.39	6.07
.426	5.72	5.40	-	6.03	6.10	5.87	5.90	6.10	6.35
.437	5.59	5.43	5.63	6.10	6.00	5.93	5.87	6.42	6.43
.447	5.12	5.47	5.55	6.03	6.00	5.97	5.85	6.12	6.25
30052.462	4.99	5.62	5.65	6.13	5.77	5.65	5.52	6.37	6.12
.474	4.97	-	5.80	6.13	5.67	5.55	5.65	6.34	6.13
.489	4.83	-	5.75	6.20	5.67	5.57	5.65	6.45	6.48
.501	5.13	5.55	5.77	6.10	5.70	5.55	5.73	6.46	6.37
30078.418	5.94	5.70	5.60	5.45	5.93	5.80	5.70	5.75	6.04
.434	5.46	-	5.60	5.42	6.00	5.77	5.77	5.98	6.17
.470	4.96	-	5.75	5.67	5.87	5.83	5.75	5.95	6.37
.483	5.08	-	5.67	5.70	5.90	5.80	5.68	5.91	6.52
.498	5.10	-	5.78	5.85	5.83	5.83	5.78	6.02	6.26
.509	4.95	5.65	5.73	5.78	6.00	5.70	5.68	6.06	6.44
.521	5.09	5.60	5.83	5.90	6.10	5.97	5.70	6.07	6.42
.536	5.50	5.37	5.73	6.17	6.03	5.80	5.63	6.24	6.48
.548	5.75	5.23	5.70	5.90	6.03	5.70	5.65	6.14	6.39
33390.497	5.16	5.97	5.65	5.83	5.93	5.90	5.62	6.21	6.70
.534	4.93	5.97	5.68	6.07	5.83	5.97	5.68	6.45	6.72
.545	5.05	5.97	5.65	6.10	5.93	5.90	5.65	6.42	6.50
.558	5.23	6.00	5.68	6.13	5.93	5.80	5.58	6.50	6.50
.570	5.30	5.88	5.87	6.00	5.83	5.90	5.87	6.45	6.61
.586	5.86	6.00	5.72	6.03	6.00	-	5.68	6.58	6.55
33420.424	5.06	6.10	5.72	5.73	6.07	5.77	5.68	6.41	6.53
.438	5.00	6.03	5.50	5.68	5.93	5.73	5.60	6.38	6.35
.450	4.83	5.90	5.57	5.58	5.93	5.78	5.60	6.35	6.51
.476	5.00	5.70	5.47	5.62	5.73	5.82	5.60	6.47	6.44
.487	5.28	5.68	5.47	5.68	5.62	5.77	5.60	6.51	6.61
.498	5.56	5.65	5.47	5.55	5.60	5.62	5.70	-	6.75
.510	6.12	5.53	5.53	5.53	5.57	5.77	5.73	6.52	6.70
.523	-	5.43	5.60	5.83	5.50	5.73	5.73	6.78	-
33421.385	5.10	5.80	5.53	5.77	5.93	5.70	5.80	-	6.03
.442	5.54	5.93	5.37	5.87	5.78	5.52	5.37	6.04	6.18
.454	5.97	5.90	5.47	5.85	5.97	5.73	5.47	6.01	6.17
.465	5.80	5.73	5.37	5.90	5.87	5.62	5.37	5.88	-
.475	5.58	5.97	5.33	5.73	5.83	-	5.33	5.90	6.29
.486	-	5.83	5.40	5.77	5.93	5.65	5.40	5.62	6.57
.497	5.12	5.90	5.43	5.80	6.00	5.50	5.43	5.61	-
.535	4.98	5.90	5.60	5.68	5.83	5.80	5.60	5.74	6.47
.548	4.96	5.87	5.63	5.65	6.02	5.90	5.63	5.71	-
33422.398	6.04	5.77	5.63	5.87	5.87	5.63	5.92	6.59	6.13
.431	5.22	-	5.53	5.92	-	5.57	5.87	-	6.25
.442	4.91	5.87	5.73	6.03	5.60	-	6.00	6.60	6.18

Table 4 (continued)

J.D. 24...	141	144	152	166	167	177	178	v.Z. 89	v.Z. 1221
33422.452	4.86	5.97	5.72	5.90	5.68	5.70	6.13	-	-
.462	4.89	-	-	-	-	-	-	-	-
.472	5.00	5.93	5.70	6.10	5.67	5.58	6.07	6.63	6.65
.483	5.12	6.03	5.72	6.07	5.70	5.80	5.75	6.55	6.57
.493	4.99	6.03	5.53	6.13	5.40	5.57	5.50	6.45	6.69
.508	5.16	5.97	5.73	5.97	5.47	5.60	5.62	6.56	6.70
.520	5.50	5.77	5.73	6.03	5.60	5.68	5.55	6.64	6.75
33763.406	5.96	5.80	5.73	5.93	5.93	5.67	5.67	6.46	6.66
.420	5.61	5.73	5.63	5.93	6.00	5.60	5.58	6.45	6.44
.442	5.19	5.80	5.60	5.87	6.00	5.60	5.53	6.52	6.44
.455	5.05	6.00	5.77	6.03	6.17	5.75	5.73	6.19	6.47
.464	5.05	5.83	5.73	6.10	6.07	5.77	5.70	6.07	6.50
.483	5.03	5.97	5.58	5.97	6.07	5.62	5.68	6.08	6.56
.494	5.16	5.97	5.58	5.90	6.03	5.72	5.68	6.06	6.51
.504	5.13	6.03	5.80	6.10	6.13	5.90	5.80	5.88	6.56
.514	5.29	5.90	5.70	6.07	6.23	5.80	5.83	5.83	6.66
.525	5.61	5.87	5.60	6.03	6.27	5.83	5.78	5.82	6.55
34118.355	5.17	5.90	5.40	5.68	5.83	5.62	5.80	5.81	-
.372	5.05	5.75	5.37	5.80	5.90	5.62	5.83	5.66	6.48
.388	5.24	5.78	5.37	5.90	5.78	5.52	5.62	5.99	-
.428	5.72	5.93	5.73	5.97	6.00	-	5.80	6.20	-
.443	5.43	6.03	5.80	5.93	6.03	5.65	5.73	6.00	6.32
.470	5.03	5.88	5.50	5.80	5.97	5.40	5.50	5.90	-
.485	4.77	5.93	5.83	5.72	6.03	5.80	5.63	6.08	-
.499	5.03	5.90	5.73	5.68	5.93	5.83	5.67	6.16	-
.513	4.98	5.83	5.90	5.73	5.87	5.87	5.65	6.37	6.54
.526	5.10	5.63	5.63	5.60	5.87	5.70	5.60	-	-
.540	5.48	6.07	5.93	5.97	5.92	5.90	5.63	6.30	-
34120.471	5.20	5.67	-	5.77	5.67	5.62	-	6.26	6.32
.484	5.12	5.47	5.80	6.00	5.77	5.47	-	-	-
.497	5.03	5.43	5.60	5.97	5.68	5.60	5.60	-	-
.510	5.00	-	5.68	6.10	-	5.50	5.68	6.39	-
.523	5.06	5.40	5.70	5.97	5.68	5.62	5.70	6.33	6.55
.536	5.12	5.35	5.68	5.97	5.78	5.65	5.68	6.50	6.87
.551	5.23	5.27	5.73	6.10	5.80	5.73	5.80	6.35	-
.564	5.61	5.40	5.57	5.93	5.68	5.57	5.80	6.50	-
.579	5.68	5.47	5.53	5.90	5.70	5.55	5.60	6.45	-
34121.401	5.72	5.77	5.67	5.68	5.75	5.75	5.62	6.33	6.17
.412	5.34	5.72	5.55	5.72	6.03	5.75	5.60	6.02	6.63
.422	5.20	5.77	5.70	5.73	5.80	5.80	5.65	6.00	6.36
.431	5.03	5.83	5.60	5.68	5.90	5.82	5.60	5.95	6.49
.441	4.87	5.83	5.77	5.80	6.00	5.80	5.50	5.94	6.80
.484	5.04	5.87	5.70	5.92	5.97	5.70	5.63	5.76	6.61
.495	5.19	5.97	5.83	5.90	5.97	5.72	5.62	5.83	6.67
.505	5.54	5.97	5.77	5.83	6.00	5.62	5.62	5.75	6.55
.517	5.83	5.90	5.77	5.93	5.97	5.68	5.77	5.68	-
.528	5.76	5.73	5.67	5.78	5.90	5.60	5.60	5.87	6.61
.539	5.57	5.90	5.60	5.93	6.00	5.53	5.60	5.89	6.52
.552	5.27	5.85	5.45	5.87	5.90	5.40	-	5.84	6.76
.562	5.09	5.80	5.50	5.90	5.80	5.30	-	5.83	6.53
.594	5.00	5.93	5.53	5.87	5.93	5.68	5.62	6.11	6.50
.605	5.22	-	5.45	5.93	5.87	5.70	5.85	6.13	6.60
34122.404	5.12	5.52	-	5.68	5.67	5.65	-	6.04	6.23
.416	5.20	5.55	5.68	5.80	5.57	5.85	5.72	6.26	6.27
.431	5.19	5.62	5.60	5.73	5.68	5.70	5.70	6.30	6.24
34126.433	5.13	5.80	5.63	5.75	5.70	5.65	5.80	6.40	6.45
34131.415	4.98	5.73	-	5.72	5.78	5.62	-	6.40	-
34487.347	5.41	6.05	5.77	5.62	6.08	5.47	5.77	6.31	6.61

Table 4 (continued)

J.D. 24...	141	144	152	166	167	177	178	v.Z. 89	v.Z. 1221
34487.367	–	6.00	5.80	5.50	6.00	5.53	5.87	6.12	6.30
.385	5.19	6.00	5.93	5.72	6.13	5.75	5.93	6.12	6.28
.397	5.14	6.03	5.80	5.77	5.97	5.55	5.77	6.37	5.81
.410	5.35	5.97	5.67	5.87	5.97	5.57	5.60	6.31	5.78
.428	5.39	6.07	5.68	5.87	6.07	5.67	5.52	6.20	5.76
.438	5.60	6.00	5.83	5.93	6.03	5.73	5.55	6.10	–
.449	6.19	6.10	5.77	5.90	5.93	5.93	5.62	6.33	–
.460	5.93	5.93	5.72	5.93	5.93	5.67	5.63	6.30	–
.474	5.76	5.77	5.43	6.00	6.03	5.70	5.43	6.56	–
.483	5.44	5.55	5.27	5.97	5.92	–	5.37	6.35	–
.494	5.30	5.62	5.40	5.93	5.90	–	5.43	6.35	–
.508	5.18	5.60	5.13	6.03	6.00	–	5.43	6.32	–
.518	5.10	5.37	5.27	6.00	5.93	–	5.53	–	–
34488.530	6.12	5.85	5.37	6.03	5.97	5.63	5.43	6.23	–
.540	6.00	–	5.42	6.03	6.07	–	5.48	5.92	–
34567.388	6.02	5.87	5.50	5.58	5.65	5.52	5.62	5.82	–
35223.415	5.20	5.30	5.73	5.97	5.97	5.43	6.65	5.92	–
.428	5.09	5.43	5.70	6.00	5.93	5.37	5.62	5.93	–
.441	–	5.50	5.70	5.97	5.97	5.65	5.62	5.97	–
.467	5.14	5.27	5.70	5.87	6.00	5.73	5.40	6.14	–
.490	5.49	5.58	5.65	5.90	5.97	5.67	5.50	6.00	5.75
.503	5.93	5.72	5.60	5.82	5.93	5.65	5.57	6.13	–
.517	5.98	5.68	5.60	5.80	5.93	5.67	5.43	6.16	–
.530	5.36	5.50	5.33	5.68	5.83	–	5.57	6.22	–
.546	5.24	5.88	5.30	5.47	5.92	5.62	5.60	6.22	–
.573	5.05	5.65	5.37	5.25	5.90	5.65	5.50	6.49	–
35224.454	6.00	5.78	5.62	5.90	5.63	5.52	5.63	6.58	–
.472	5.22	5.88	5.58	5.70	5.65	5.33	5.58	6.72	–
.485	5.24	5.90	5.73	5.63	5.77	5.57	5.58	6.53	–
.499	5.02	5.88	5.53	5.67	5.80	5.55	5.47	6.38	–
.512	5.11	5.87	5.43	5.63	5.62	5.52	5.50	6.64	–
.524	5.00	–	5.37	5.60	5.60	5.40	5.43	6.33	–
.542	5.16	5.77	5.45	5.58	5.70	5.55	5.50	6.30	–
.556	5.19	5.50	5.47	5.47	5.87	5.78	5.50	6.08	–
.569	5.65	–	5.17	5.52	5.72	–	5.40	–	–
.583	5.96	5.33	5.43	5.40	5.97	–	5.47	6.02	–
35227.534	5.46	5.67	5.60	5.63	5.53	5.30	5.60	6.41	5.31
.547	5.76	5.57	5.40	5.77	5.63	5.45	5.63	6.50	5.45
.560	6.06	5.30	5.68	5.57	5.80	5.20	5.53	6.61	5.77
.573	5.16	5.23	5.37	5.60	5.73	5.37	5.80	6.24	–
.586	–	5.30	–	5.58	5.63	5.40	5.80	6.60	5.77
35598.507	5.20	5.97	5.77	5.80	5.68	5.27	5.53	5.87	6.06
.524	5.12	5.87	5.70	5.83	5.70	5.50	5.43	5.90	6.10
.537	5.02	5.80	5.65	5.90	5.60	5.33	5.27	5.94	6.20
35600.363	5.88	5.90	–	5.43	5.57	5.60	5.50	5.92	6.07
.378	5.43	5.80	5.53	5.43	5.50	5.47	5.43	5.92	5.29
.391	5.34	5.87	5.67	5.47	5.60	5.68	5.53	5.75	5.53
.405	5.08	5.93	5.62	5.53	–	5.68	5.40	5.86	5.66
.421	5.17	5.92	5.65	5.60	5.63	5.75	5.58	–	–
.434	5.08	6.00	5.57	5.68	5.63	5.83	5.50	5.93	5.67
.446	5.22	5.95	5.77	5.70	5.67	5.75	5.47	5.89	–
.501	6.02	5.68	5.70	5.57	5.87	5.73	5.60	6.20	–
.525	5.40	5.33	5.18	5.60	5.60	5.53	5.53	6.07	–
35603.369	5.18	5.83	5.73	5.67	5.87	5.40	5.47	6.55	–
.381	5.20	5.90	5.65	5.77	6.00	5.40	5.47	6.55	6.50
.397	5.01	5.68	5.55	5.63	5.90	5.15	5.43	6.80	6.70
.408	5.12	5.93	5.62	5.68	5.80	5.37	5.47	6.52	6.26
.419	5.18	5.83	5.60	5.88	5.92	5.40	5.58	6.58	6.11

Table 4 (continued)

J.D. 24...	141	144	152	166	167	177	178	v.Z. 89	v.Z. 1221
35603.431	5.32	5.93	5.75	5.97	5.93	-	5.55	6.53	5.43
.466	5.67	-	5.63	6.00	6.00	5.45	5.68	6.80	-
.457	6.13	5.80	5.62	5.97	5.90	5.43	5.62	6.55	5.28
.468	6.09	5.90	5.50	5.97	5.97	5.53	5.87	6.61	5.31
.491	5.25	5.58	5.57	5.80	5.97	5.50	5.68	6.51	-
.507	5.24	5.52	-	5.97	5.77	5.50	-	6.16	5.64
35920.444	5.68	-	5.90	5.87	5.82	5.65	5.83	6.63	6.22
.467	6.11	5.80	5.60	5.93	5.83	-	5.50	6.39	6.13
.487	-	5.50	5.50	5.73	-	5.50	5.73	6.34	-
.504	5.18	5.55	5.47	5.70	5.73	-	5.47	-	6.22
.547	5.10	-	5.65	5.78	6.03	-	5.80	6.43	6.72
.562	5.20	5.80	5.50	5.80	5.90	-	5.63	6.35	6.58
.585	5.51	-	5.27	5.97	5.87	-	5.57	-	6.33
35933.415	6.28	5.90	5.72	5.87	5.90	5.60	5.68	6.51	6.58
.443	5.34	5.87	5.73	5.83	5.77	5.75	5.60	6.18	6.71
.479	4.90	5.83	5.73	5.80	5.87	5.93	5.83	5.92	6.59
.503	5.09	-	-	-	-	-	-	5.45	5.07
.515	5.36	-	-	-	-	-	-	5.37	4.80
.530	-	-	-	5.87	5.87	-	-	5.36	4.72
.543	5.99	-	-	-	-	-	-	5.51	4.59
.573	5.48	-	5.37	5.68	5.87	-	5.13	5.78	5.23
.588	5.10	-	-	-	-	-	-	5.81	5.42
.602	5.03	-	-	-	-	-	-	-	5.30
36991.457	6.00	-	5.20	6.00	5.57	5.50	5.70	5.75	6.69
.470	5.84	-	-	5.97	5.63	5.55	-	5.82	-
.485	5.31	5.95	5.20	5.70	5.55	5.40	-	5.91	6.43
37018.470	5.04	5.93	5.63	5.63	5.50	5.43	5.50	6.21	-
.483	4.90	5.87	5.70	5.73	5.70	5.65	5.42	6.51	6.36
.496	4.95	5.75	5.47	5.72	5.60	5.68	5.60	6.34	5.95
.510	5.00	-	5.30	5.47	5.65	5.60	5.45	-	5.35
.523	5.10	5.93	5.30	5.53	5.77	5.67	5.57	6.23	5.10
.537	-	5.80	5.43	5.62	5.73	-	5.47	-	5.19
.550	5.88	5.85	5.07	5.27	5.47	-	5.53	6.36	5.31
.563	-	-	-	-	-	-	-	6.31	5.38
.577	5.26	5.67	5.50	5.50	5.60	-	-	6.45	5.46
.609	4.95	5.77	5.50	5.72	5.80	5.70	5.57	6.50	5.56
.623	-	-	-	-	-	-	-	-	5.79
.637	4.79	5.90	5.57	5.93	5.90	5.60	5.63	6.27	5.59
37057.539	5.06	5.43	5.60	5.77	5.90	5.70	5.80	-	-
.552	4.84	5.50	5.70	5.90	5.97	5.80	5.57	6.17	6.59
.578	5.00	5.70	5.83	5.63	6.00	-	5.77	6.21	6.41
37058.529	4.79	6.03	5.97	5.93	5.93	5.83	5.60	6.26	6.70
.580	6.14	-	5.83	5.80	5.87	5.80	5.77	6.27	6.51
37757.598	5.00	5.30	-	5.62	5.90	-	-	5.61	6.36
37791.365	4.80	6.03	5.97	5.87	5.90	5.77	5.70	5.73	5.71
.380	5.28	5.90	5.83	5.90	5.87	5.87	5.73	5.70	5.84
.394	5.63	5.97	5.97	5.97	6.00	5.60	5.90	5.71	5.89
.424	5.08	5.80	5.87	5.97	6.00	5.63	5.80	5.69	5.99
.439	4.83	6.13	5.65	5.80	5.93	5.90	5.73	5.71	6.08
.454	4.68	5.80	5.65	6.03	6.10	5.80	5.70	5.83	6.25
.469	4.64	6.10	5.83	5.93	6.07	5.90	5.90	5.89	6.25
.483	-	6.00	5.57	5.80	5.97	5.80	5.73	5.98	6.17
.497	5.05	5.90	5.68	5.83	5.90	5.87	5.80	5.88	6.33
.519	5.81	5.65	5.70	5.80	5.93	5.90	5.87	6.09	6.48
.533	5.90	5.50	5.77	5.97	6.00	5.83	5.97	6.18	6.59
.549	5.30	5.25	5.72	5.80	5.93	5.90	5.77	6.14	6.70
.563	5.06	5.23	5.63	5.97	5.93	5.80	5.67	6.46	6.59

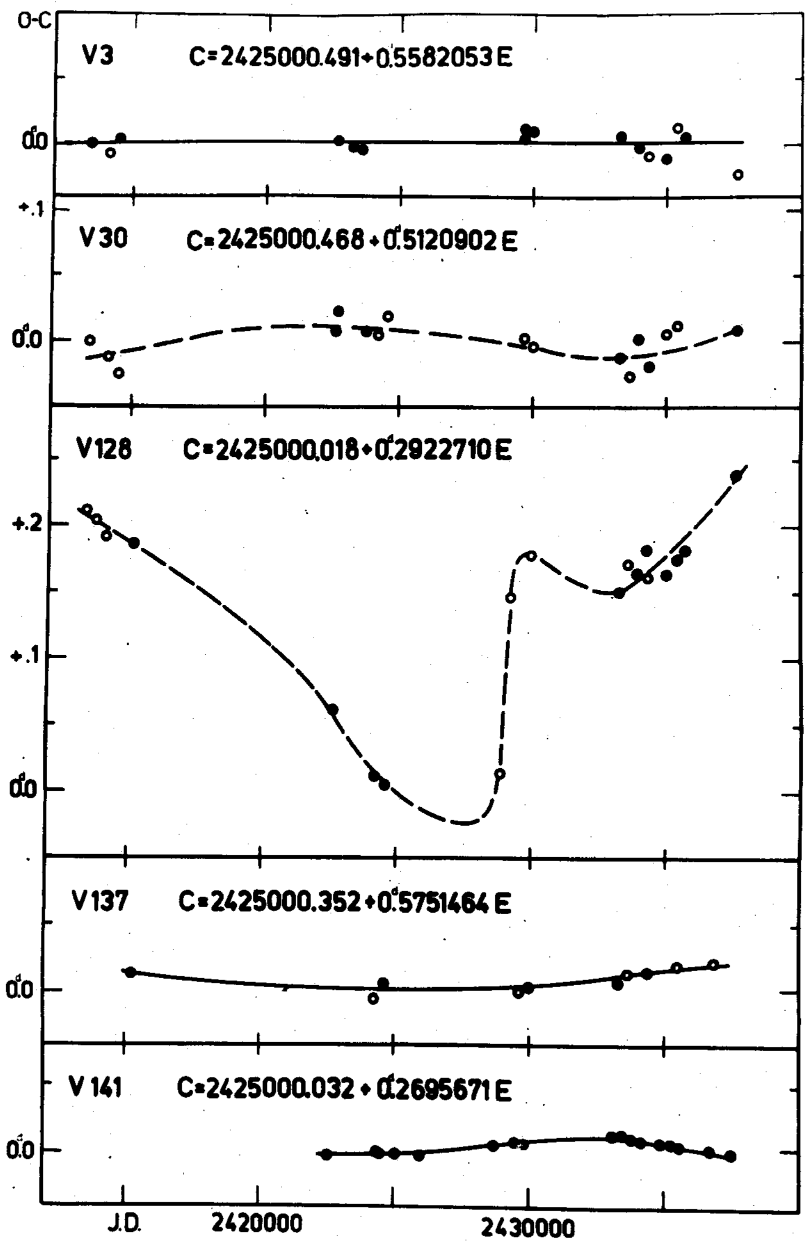

Fig. 3a O - C diagrams of variables Nos. 3, 30, 128, 137 and 141

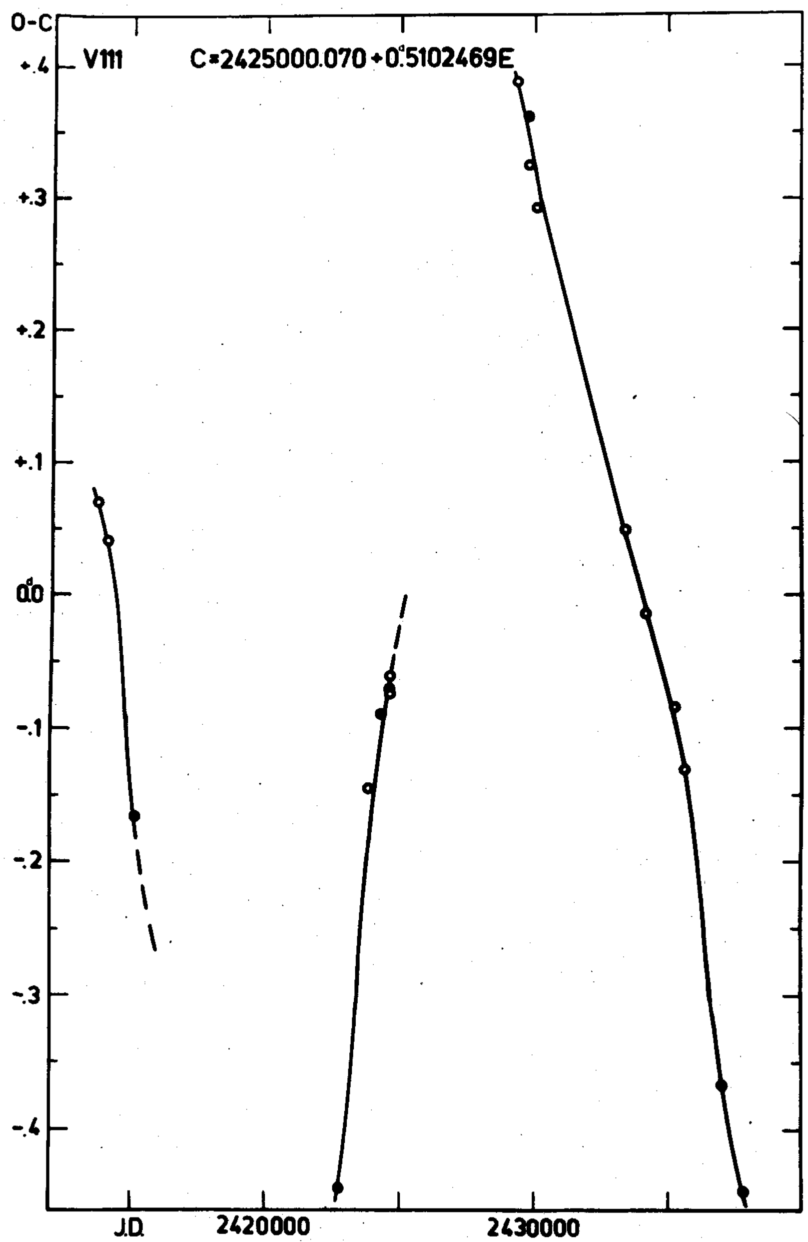

Fig. 3b O - C diagram of variable No. 111

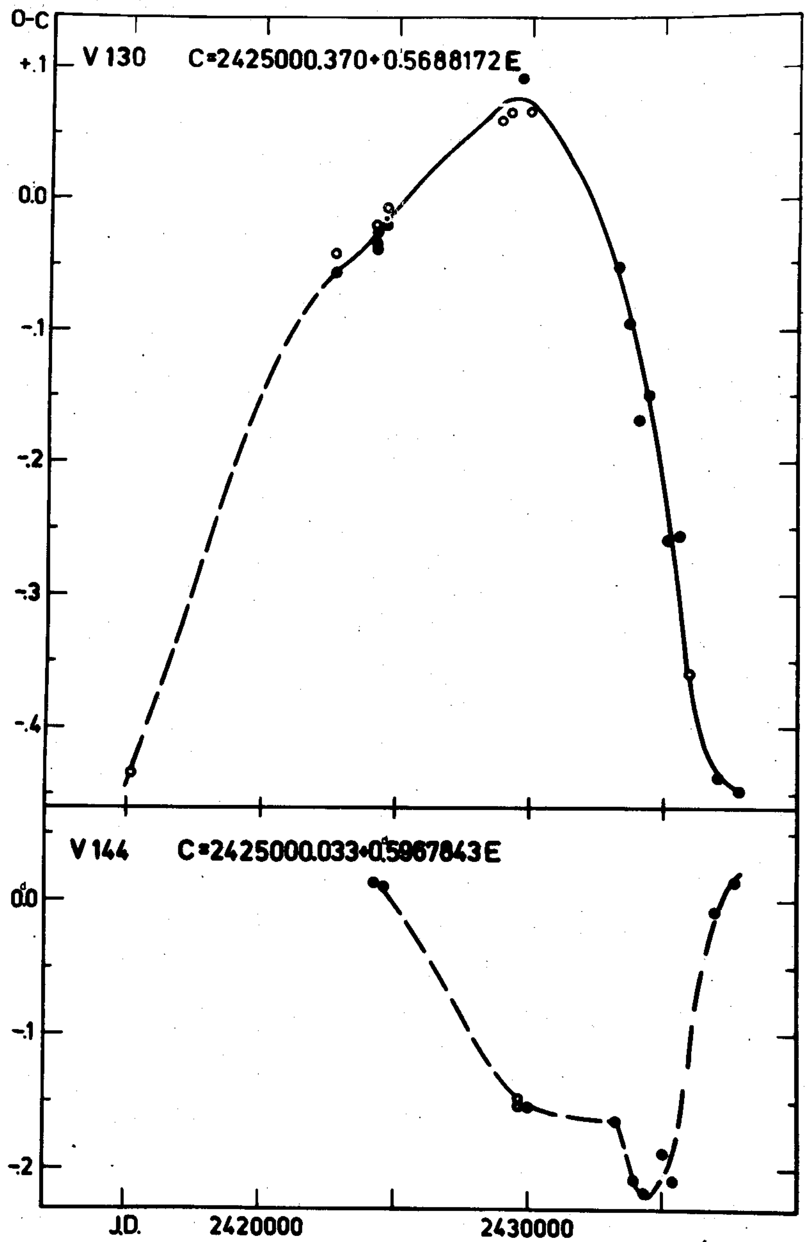

Fig. 3c O - C diagrams of variables No. 130 and No. 144

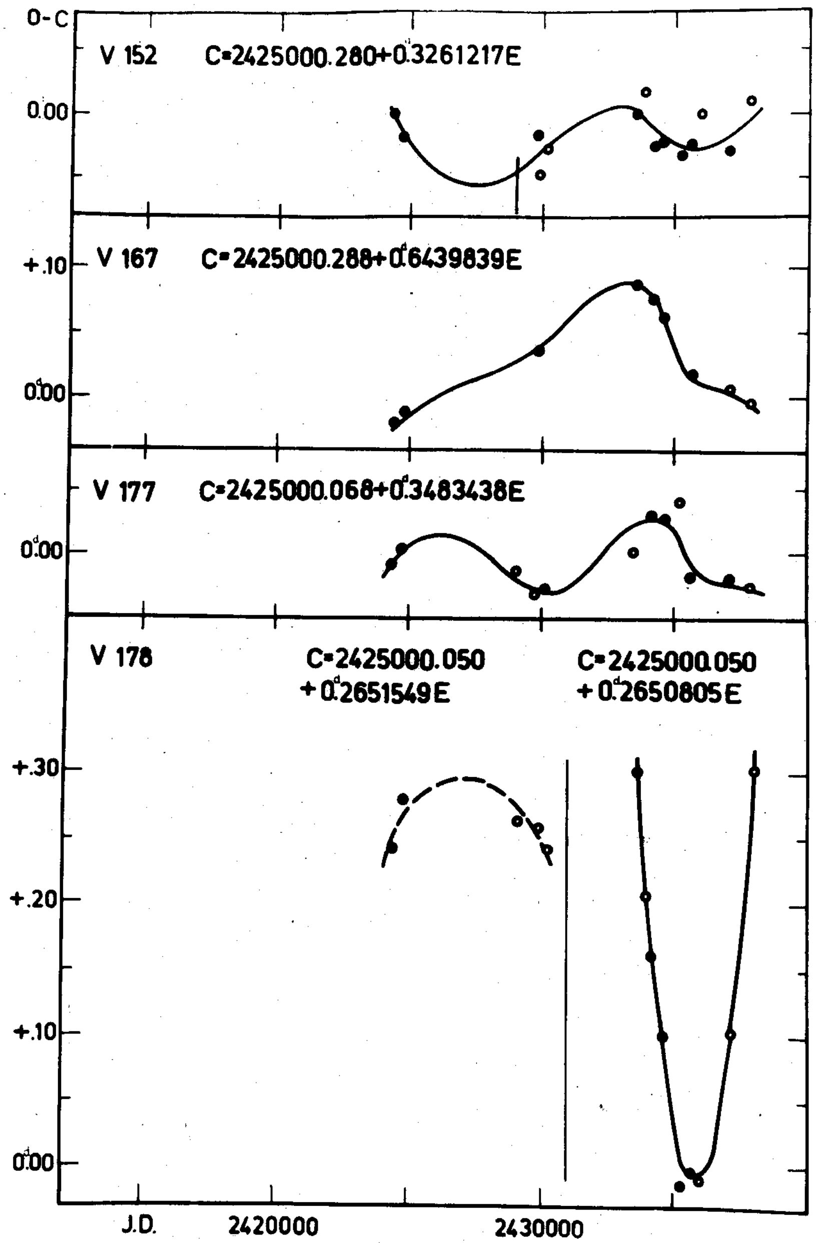

Fig. 3d O - C diagrams of variables Nos. 152, 167, 177, and 178

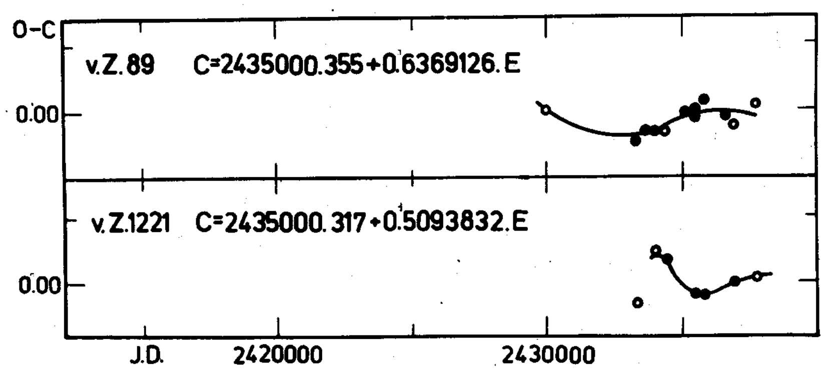

Fig. 3e O - C diagrams of variables SVS 1264 = v.Z.89 and SVS 1276 = v.Z.1221

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Budapest, Konkoly Observatory, 1972 December

REFERENCES

Baade, W., 1931, Astron. Nachr. 243. 179

Bailey, S.I., 1913, Harvard Ann. 78. 1

Graff, K., 1923, Astron. Nachr. 217. 309

1931, Astron. Nachr. 241. 197

Greenstein, J.L., 1935, Astron. Nachr. 257. 301

Guthnick, P., 1933, Sitzungsberichte d. Preussischen Akademie d.Wissenschaften Phys.-Math. Klasse, XXIV.

Kukarkin, B.V., 1960, Astr. Circ. 216. 29

Kurochkin, N.E., 1959, Astr. Circ. 205. 14

1961, Per. Zvezdy 13. 2

Larink, J.,1921, Astron. Nachr. 214. 71

1922, Hamburg-Berg. Abh. 2. Nr. 6

Martin, W.Ch., 1942, Astrophys. Journal 95. 314

Müller, Th., 1933, Berlin-Babels. Veröff. 11. 1

Roberts, M. and Sandage, A., 1955, Astron.Journal 60. 185

Russev, R.M., 1971, Per. Zvezdy 18, 171

Rybka, E., 1930, BAN 5. 257

Sandage, A., 1953, Astron. Journal 58. 61

Sawyer, H.B.,1955, Publ. D.D.O. 2. No.2

Schilt, J., 1927, Astrophys. Journal 65, 124

Slavenas, P., 1929, Astron. Nachr. 240. 169

Szeidl, B., 1965, Budapest Mitt. Nr.58

A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST-SZABADSÁGHEGY

Nr. 64.

S. KANYÓ and B. SZEIDL

PHOTOELECTRIC OBSERVATIONS OF AN SERPENTIS

BUDAPEST, 1974

PHOTOELECTRIC OBSERVATIONS OF AN SERPENTIS

SUMMARY

Three-colour photoelectric photometry of the RRab star AN Serpentis is presented. The period changes of the star is investigated. No light curve variation or non-repetitive behaviour were noted during the time interval covered by our observations.

INTRODUCTION

The light variation of AN Serpentis = 45.1935 was discovered by HOFFMEISTER (1935) and its type and period were first determined by SOLOVIEV (1935). Since the time of its discovery several observers have investigated the variable visually and photographically (SOLOVIEV 1936a, b, 1940a, b; PRAGER 1941; van SCHEWICK 1942; GAPOSCHKIN 1952; PAYNE-GAPOSCHKIN 1954; ALANIJA 1954; BATYREV 1957, 1964; TSESSEVICH 1966) and photoelectrically (SPINRAD 1959, 1961; FITCH et al. 1966; STURCH 1966; SZEIDL 1968; BASU 1968). JOY (1950) measured the radial velocity of the star and found a value of -60 km/sec for its normal radial velocity.

From his visual observations BATYREV (1957) came to the conclusion that the star had Blazhko-effect with a period of 22.94 days. His result was, however, uncertain because of the large scattering of the visual observations. Furthermore, it also seemed curious that an RRab star with high metal abundance like AN Serpentis ($\Delta s=0$, PRESTON 1959) had light curve variation. As can be seen from Table 1 the RR Lyrae stars with Blazhko-effect generally have a rather low metal abundance. (SW And is the only exception which is a very strangely behaving RRab star with temporary Blazhko-effect.) In order to disentangle this problem and to investigate the light curve variation suspected by BATYREV we commenced observing AN Serpentis in 1967. Since that time we have collected a large number of photoelectric observa-

Table 1

RR Lyrae stars with Blazhko-effect in case the secondary period and Δs are known

Star	Type	P_o	P_B	Δs
TV Boo	c	$0\overset{d}{.}313$	$33\overset{d}{.}5$	8
RS Boo	ab	0.377	537	2
RU Psc	c	0.390	28.8	7
RR Gem	ab	0.397	37	3
SW And	ab	0.442	36.8	0
RW Dra	ab	0.443	41.7	3
RV Cap	ab	0.448	225.5	6
XZ Cyg	ab	0.467	57.3	6.
RV UMa	ab	0.468	91	8
AR Her	ab	0.470	31.5	6
XZ Dra	ab	0.476	78	3
RZ Lyr	ab	0.511	116.7	9
SZ Hya	ab	0.537	25.8	6:
UV Oct	ab	0.543	80	9
TT Cnc	ab	0.563	89	7
RR Lyr	ab	0.567	40.8	6
AR Ser	ab	0.575	105	8:
DL Her	ab	0.592	33.6	6:
AT And	ab	0.617	82.7	3
Z CVn	ab	0.654	22.7	8:

tions in U, B and V which contradict BATYREV's result. AN Serpentis has not shown Blazhko-effect during the time interval of our observations at least.

OBSERVATIONS

Our photoelectric observations were made at both the Konkoly Observatory and the Catania Observatory.

1. At the Konkoly Observatory a total of 396 observations in yellow light, 390 observations in blue light and 193 observations in ultraviolet light were obtained during 17 nights in the years 1967, 1968 and 1971. These observations were made with the photoelectric photometer attached to the 24" reflector of the Konkoly Observatory. The photometer employed an unrefrigerated EMI 9502 B photomultiplier and the following Schott filters: 2mm UG 1 for ultraviolet light; 1 mm BG 12 plus 2 mm GG 13 for blue light and 2 mm GG 11 for yellow light.

A nearby comparison star was observed with AN Serpentis, and 3 nights this comparison star, (BD+13°3025 (9.5), was tied to the Johnson and Morgan UBV system by observations of standard stars. The results for BD+13°3025 are as follows:

$$V = 10.66 \quad B - V = +0.63 \quad U - B = +0.17$$

The U - B, B - V colours of the comparison star fit well the standard U - B, B - V relation for main sequence stars. According to the Sp, B - V relation the star is of spectral type G2V.

Very likely STURCH (1966) and BASU (1968) used the same comparison star since the photometric data of their comparison star agree very well with the data given above. They give the following photometric values for their comparison star:

	STURCH		BASU
V =	10.682	and	10.670
B - V =	+0.637	and	+0.625
U - B =	+0.187		

All the observations of the variable obtained at the Konkoly Observatory are reduced to the time of observations in yellow. Corrections for differential extinction were usually made with extinction coefficients determined for the particular night from the comparison star. On a few occasion a mean extinction coefficient was adopted. Observations of standard stars were used to transform the differential magnitudes and colours in instrumental system to the UBV system. These tie-in observations were made on several good and uniform nights and indicated that

$$\Delta V = \Delta y + \varepsilon\Delta(B - V)$$
$$\Delta(B - V) = \mu\Delta(b - y)$$
$$\Delta(U - B) = \psi\Delta(u - b)$$

where the small letters refer to instrumental quantities reduced to no atmosphere, and ε,μ and ψ are the scale factors.The scale coefficients derived on different nights of tie-in observations showed some small variations which probably resulted from instrumental and temperature effects, uncertain extinction terms and observational errors.

In Table 2 the observations of AN Serpentis on UBV system obtained at the Konkoly Observatory are listed.The magnitude differences are given as variable minus comparison (BD+13°3025).

2. At the Catania Observatory the observations were taken with the 61 cm Cassegrain reflector equipped with a standard three-colour photometer containing an unrefrigerated EMI 6256 photomultiplier tube.

In 1970 during two nights 97 observations of AN Serpentis were obtained, 40 in yellow, 40 in blue and 17 in ultraviolet light. As comparison star we used BD+13°3026 (9.5). According to our tie-in observations its brightness and colours are as follows:

V = 10.51 B - V = +0.94 U - B = +0.64

Table 2

J.D. 2400000+	Phase	ΔV	Δ(B-V)	Δ(U-B)
39527.6413	.8687	+.679	-.067	
.6461	.8779	.652	.079	
.6475	.8805	.633	.092	
.6510	.8872	.632	.148	
.6524	.8899	.624	.155	
.6566	.8980	.571	.174	
.6580	.9006	.542	.193	
.6607	.9058	.475	.262	
.6621	.9085	.453	.232	
.6642	.9125	.409	.253	
.6656	.9152	.374	.246	
.6677	.9192	.351	.289	
.6691	.9219	.324	.253	
.6711	.9257	.246	.251	
.6725	.9284	.208	.245	
.6746	.9324	.173	.271	
.6760	.9351	.140	.282	
.6781	.9391	.110	.316	
.6795	.9419	.106	.320	
.6816	.9459	.095	.332	
.6829	.9483	.077	.318	
.6850	.9524	.058	.383	
.6864	.9550	+.028	.371	
.6885	.9591	-.036	.373	
.6899	.9618	.055	.377	
.6920	.9658	.091	.376	
.6934	.9685	.144	.338	
.6954	.9723	.163	.366	
.6968	.9750	.168	.401	
.6989	.9790	.186	4414	
.7003	.9817	-.219	-.395	
39537.6230	.9880	-.212	-.477	
.6244	.9907	.213	.497	
.6272	.9961	.247	.439	
.6286	.9987	.270	.437	
.6314	.0041	.239	.478	
.6356	.0122	.221	.465	
.6370	.0148	.259	.442	
.6397	.0200	.227	.433	
.6411	.0227	-.214	-.439	
39538.6095	.8776	+.645	-.098	-.052
.6116	.8816	.626	.110	.078
.6158	.8897	.618	.220	.017
.6179	.8937	.606	.253	.029
.6221	.9017	.554	.273	-.015
.6242	.9058	.481	.257	+.005
.6283	.9136	.397	.223	-.090
.6304	.9176	.358	.277	.130
.6345	.9255	.266	.290	.159
.6366	.9295	+.221	-.314	-.135
39538.6408	.9376	+.168	-.366	-.093
.6429	.9416	.143	.366	.081
.6471	.9496	.110	.367	.091
.6492	.9536	+.079	.375	-.039
.6533	.9615	-.003	.450	+.009
.6554	.9655	.068	.429	-.012
.6595	.9734	.163	.409	+.018
.6616	.9774	.192	.400	+.018
.6658	.9854	.223	.450	-.015
.6679	.9895	.239	.442	.061
.6721	.9975	.263	.459	.047
.6742	.0015	.273	.443	.038
.6783	.0094	.277	.400	.040
.6804	.0134	.261	.440	.001
.6845	.0213	.233	.470	.014
.6866	.0253	.234	.438	-.022
.6908	.0333	-.228	-.410	
39547.5203	.9457	+.107	-.342	
.5217	.9484	.059	.307	
.5245	.9538	+.003	.310	
.5286	.9616	-.031	.396	
.5300	.9643	.046	.447	
.5342	.9723	.095	.476	
.5369	.9775	.131	.470	
.5384	.9804	.154	.495	
.5412	.9858	.202	.479	
.5426	.9884	.231	.458	
.5453	.9936	.238	.479	
.5467	.9963	.243	.472	
.5495	.0016	.236	.483	
.5509	.0043	.236	.472	
.5536	.0095	.232	.476	
.5550	.0122	.239	.456	
.5578	.0175	.235	.418	
.5592	.0202	-.222	-.407	
39560.5605	.9235	+.301	-.260	
.5723	.9461	.080	.309	
.5737	.9487	+.047	.307	
.5946	.9888	-.246	.421	
.6015	.0020	.215	.476	
.6029	.0047	.246	.453	
.6057	.0100	.245	.436	
.6071	.0127	-.229	-.444	
39562.5232	.6829	+.643	-.083	-.061
.5253	.6869	.645	.083	.073
.5295	.6950	.635	.074	.049
.5316	.6990	.652	.046	.087
.5357	.7068	.638	.018	.081
.5378	.7109	+.644	-.022	-.013

Table 2 (continued)

J.D. 2400000+	Phase	ΔV	Δ(B-V)	Δ(U-B)
39562.5420	.7189	+.664	-.021	-.044
.5441	.7229	.667	.027	-.026
.5482	.7308	.669	.072	+.001
.5503	.7348	.667	.063	-.051
.5545	.7428	.698	.094	.040
.5566	.7469	.707	.085	.011
.5607	.7547	.708	.094	.031
.5628	.7587	.692	.081	.003
.5670	.7668	.704	.065	.015
.5732	.7787	.699	.037	.019
.5753	.7827	.708	.076	.012
.5795	.7907	.694	.048	-.008
.5816	.7948	.711	.067	.000
.5857	.8026	.723	.059	-.007
.5878	.8066	.708	.037	.015
.5920	.8147	.710	.033	.007
.5941	.8187	.713	.031	.023
.5982	.8266	.715	.046	.020
.6003	.8306	.719	.057	-.039
.6045	.8386	.722	.057	+.007
.6066	.8426	.698	.021	-.054
.6107	.8505	.712	.040	.058
.6128	.8545	.721	.040	.074
.6177	.8639	.705	.033	.022
.6198	.8679	.684	.035	.030
.6281	.8838	+.646	-.142	-.034
39570.5390	.0367	-.178	-.479	+.011
.5411	.0407	.175	.471	-.007
.5464	.0509	.152	.453	.018
.5515	.0606	.134	.428	.038
.5536	.0647	.121	.439	.044
.5578	.0727	.118	.397	.071
.5599	.0767	-.100	-.404	-.050
39600.4766	.3804	+.405	-.143	-.077
.4787	.3844	.407	.182	.035
.4829	.3925	.430	.189	.040
.4850	.3965	.439	.171	.069
.4891	.4043	.447	.184	.044
.4912	.4084	.444	.190	.051
.4954	.4164	.442	.183	-.026
.4975	.4204	+.463	-.204	+.036
39611.4385	.3773	+.381	-.140	-.084
.4687	.4351	.479	.131	.076
.4708	.4391	.466	.121	.037
.4759	.4489	.480	.125	.028
.4812	.4591	.508	.163	.032
.4833	.4631	.515	.161	.030
.4874	.4709	+.534	-.200	-.003
39611.4916	.4790	+.529	-.170	+.011
.4958	.4870	.519	.131	-.032
.4999	.4949	.523	.131	-.060
.5020	.4989	.525	.161	.000
.5062	.5070	.527	.161	+.013
.5083	.5110	.512	.142	-.011
.5134	.5207	.511	.122	-.028
.5249	.5428	.518	.086	
.5305	.5535	.530	.111	+.003
.5384	.5686	.509	.086	-.005
.5437	.5788	.515	.066	+.016
.5458	.5828	.519	.071	-.022
.5499	.5907	.531	.079	.025
.5520	.5947	.543	.094	.037
.5562	.6027	.559	.105	.038
.5583	.6067	.572	.096	-.044
.5624	.6146	.602	.109	
.5645	.6186	.569	.093	
.5687	.6267	.600	.102	
.5708	.6307	.610	.088	
.5749	.6385	.595	.091	-.009
.5770	.6426	.601	.077	.056
.5812	.6506	.603	.079	.014
.5833	.6546	.621	.108	.020
.5874	.6625	.595	.073	.020
.5895	.6665	+.610	-.064	-.059
39617.4375	.8680	+.724	-.087	
.4416	.8759	.662	.071	
.4437	.8799	.646	.076	-.085
.4479	.8879	.638	.179	-.040
.4499	.8918	.620	.146	
.4541	.8998	.539	.163	-.003
.4562	.9038	.518	.170	-.014
.4604	.9119	.405	.235	
.4625	.9159	.353	.229	+.008
.4666	.9238	.292	.314	-.074
.4687	.9287	.238	.259	.099
.4729	.9358	.161	.288	.124
.4750	.9398	.120	.304	.174
.4791	.9477	.074	.287	.166
.4812	.9517	.056	.320	.146
.4854	.9598	+.008	.379	.073
.4874	.9636	-.022	.399	.071
.4916	.9716	.121	.390	.103
.4937	.9757	.162	.383	.115
.4979	.9837	.217	.431	.098
.4999	.9875	.234	.439	.079
.5041	.9956	.236	.448	.091
.5062	.9996	.233	.444	.103
.5104	.0076	-.240	-.422	-.114

Table 2 (continued)

J.D. 2400000+	Phase	ΔV	Δ(B−V)	Δ(U−B)
39617.5124	.0115	−.235	−.437	−.084
.5166	.0195	.220	.429	.068
.5187	.0235	.215	.447	.043
.5229	.0316	.190	.462	.037
.5249	.0354	.185	.445	.033
.5291	.0435	.189	.416	.062
.5312	.0475	.169	.431	.066
.5354	.0555	.155	.411	.112
.5374	.0594	.157	.390	.084
.5416	.0674	.130	.388	.087
.5437	.0714	.119	.366	.115
.5479	.0795	.104	.373	.021
.5499	.0833	.096	.368	.036
.5541	.0914	.091	.339	.053
.5562	.0954	.067	.342	.033
.5604	.1034	.026	.370	−.018
.5624	.1073	.015	.393	+.018
.5666	.1153	−.007	.381	+.019
.5687	.1193	+.006	.371	−.015
.5729	.1274	.005	.312	−.027
.5749	.1312	.015	.331	+.009
.5791	.1392	.037	.339	+.011
.5812	.1433	+.055	−.327	−.025
39673.4461	.1492	+.049	−.300	−.071
.4482	.1532	.063	.305	.062
.4523	.1611	.069	.314	−.012
.4544	.1651	.083	.335	+.002
.4593	.1745	.073	.312	−.006
.4614	.1785	.075	.266	.040
.4655	.1864	.122	.290	.046
.4676	.1904	.142	.293	.052
.4725	.1998	.165	.284	−.053
.4787	.2116	.185	.331	
.4808	.2157	.171	.317	
.4850	.2237	.180	.325	
.4863	.2262	.196	−.320	
.4891	.2316	.199		
.4905	.2343	.203	−.310	
.4933	.2396	.234	.283	
.4947	.2423	.229	.297	
.4989	.2503	.241	.296	
.5016	.2555	.220	−.246	
.5030	.2582	.223		
.5120	.2754	.227	−.235	
.5148	.2808	.271	.233	
.5162	.2835	.275	.231	
.5190	.2888	.260	.239	
.5204	.2915	.275	.215	
.5231	.2967	.271	.214	
.5245	.2994	+.257	−.210	

J.D. 2400000+	Phase	ΔV	Δ(B−V)	Δ(U−B)
39967.4402	.2776	+.251	−.271	
.4423	.2817	.281	.265	
.4465	.2897	.279	.226	−.035
.4486	.2937	.265	−.182	−.028
.4527	.3016	.280		
.4548	.3056	.310	−.219	−.015
.4590	.3137	.318	.249	−.009
.4611	.3177	.326	.246	+.008
.4652	.3255	.336	.262	
.4673	.3295	.347	.251	−.031
.4715	.3376	.373	.227	.054
.4757	.3456	.419	.223	.059
.4819	.3575	.417	.196	.017
.4861	.3656	.401	.190	.046
.4902	.3734	.387	.166	.031
.4923	.3774	.399	.188	.042
.4965	.3855	.433	.188	.061
.4986	.3895	.444	.207	.002
.5027	.3974	.425	.160	.029
.5048	.4014	.420	.145	−.020
.5090	.4094	.446	.179	
.5111	.4134	.461	.156	+.008
.5152	.4213	.470	.184	+.004
.5173	.4253	.449	.151	−.032
.5236	.4374	.466	.110	−.043
.5277	.4452	.490	.157	+.010
.5298	.4493	.484	.142	−.012
.5340	.4573	.483	.132	.038
.5361	.4613	.479	.104	.082
.5402	.4692	.479	.127	.047
.5423	.4732	.495	.146	.042
.5465	.4813	.505	.142	.038
.5486	.4853	.507	.132	.015
.5527	.4931	.536	.179	.026
.5548	.4972	.510	.131	−.027
.5590	.5052	.478	.119	+.027
.5611	.5092	.495	.141	+.024
.5652	.5171	.492	.116	−.021
.5673	.5211	.504	.128	+.002
.5715	.5291	.530	.160	+.011
.5736	.5332	.508	.151	−.009
.5777	.5410	.501	.110	.015
.5798	.5450	.514	.109	.040
.5840	.5531	.527	.132	.038
.5861	.5571	+.523	−.128	−.023
39996.4787	.8992	+.551	−.275	
.4801	.9019	.521	.277	
.4829	.9072	.494	.287	
.4843	.9099	.476	.282	
.4870	.9151	+.406	−.284	

Table 2 (continued)

J.D. 2400000+	Phase	ΔV	$\Delta(B-V)$	$\Delta(U-B)$
39996.4884	.9178	+.353	-.323	
.4912	.9231	.294	.299	
.4926	.9258	.258	.270	
.4982	.9365	.162	.345	
.4996	.9392	.109	.341	
.5023	.9444	.066	.315	
.5037	.9471	.050	.294	
.5065	.9524	.042	.299	
.5079	.9551	+.026	.310	
.5141	.9670	-.108	.353	
.5155	.9697	.121	.437	
.5183	.9750	.175	.388	
.5197	.9777	.198	.426	
.5225	.9831	.228	.431	
.5239	.9858	.231	.456	
.5266	.9909	.226	.472	
.5280	.9936	.233	.485	
.5308	.9990	.221	.514	
.5322	.0017	.223	.512	
.5357	.0084	.224	.488	
.5371	.0110	.226	.469	
.5398	.0162	.247	.451	
.5412	.0189	.230	.440	
.5440	.0243	.234	.426	
.5454	.0269	.226	.431	
.5482	.0323	.206	.463	
.5496	.0350	.194	.467	
.5523	.0402	-.202	-.451	
41095.5059	.0213	-.212	-.450	
.5080	.0253	.203	.453	
.5121	.0332	.200	.447	
.5142	.0372	.191	.426	
.5184	.0452	.196	.413	
.5212	.0506	.181	.398	
.5253	.0584	.152	.399	
.5274	.0625	.149	.381	
.5315	.0703	.126	.386	
.5336	.0743	-.114	-.356	
41096.4722	.8722	+.682	-.112	
.4736	.8749	.689	.122	
.4750	.8775	.690	.127	
.4764	.8802	.669	.123	
.4791	.8854	.652	.158	
.4805	.8881	.645	.201	
.4819	.8908	.620	.222	
.4833	.8934	.588	.183	
.4861	.8988	.549	.180	
.4875	.9015	.511	.189	
.4944	.9147	.383	.232	
.4958	.9174	+.366	-.235	
41096.4972	.9201	+.341	-.237	
.5014	.9281	.270	.301	
.5028	.9308	.226	.288	
.5042	.9335	.216	.286	
.5069	.9386	.149	.319	
.5083	.9413	.125	.293	
.5097	.9440	.131	.310	
.5111	.9467	.122	.310	
.5159	.9559	.035	.294	
.5180	.9599	+.009	.308	
.5222	.9679	-.060	.346	
.5243	.9720	.076	.390	
.5284	.9798	.167	.367	
.5305	.9838	.220	.387	
.5347	.9919	.234	.427	
.5368	.9959	.223	-.440	
.5534	.0277	.236		
.5555	.0317	-.221		
41117.3824	.9244	+.285	-.233	
.3845	.9285	.204	.264	
.3970	.9524	.035	.387	
.3984	.9551	+.011	.397	
.4011	.9603	-.063	.359	
.4025	.9629	.088	.378	
.4039	.9656	.130	.392	
.4074	.9723	.146	.395	
.4088	.9750	.167	.433	
.4102	.9777	.168	.454	
.4136	.9842	.207	.422	
.4150	.9869	.219	.448	
.4164	.9896	.226	.441	
.4254	.0068	.226	.470	
.4268	.0095	.240	.472	
.4331	.0215	.243	.449	
.4345	.0242	.215	.474	
.4359	.0269	.212	.477	
.4386	.0321	-.173	-.454	
41119.4846	.9511	+.071	-.371	
.4860	.9538	.045	.364	
.4874	.9564	+.003	.329	
.4888	.9591	-.029	.356	
.4923	.9658	.094	.340	
.4937	.9685	.118	.340	
.4951	.9712	.141	.382	
.4965	.9739	.154	.383	
.5041	.9884	.192	.424	
.5055	.9911	.201	.451	
.5068	.9936	.222	-.418	
.5082	.9963	-.235		

Table 3
Observations at Catania

J.D. 2440000+	Phase	Δm	J.D. 2440000+	Phase	Δm	J.D. 2440000+	Phase	Δm
			in yellow					
707.5424	.9000	+.655	707.5897	.9906	-.148	718.5095	.9068	+.580
.5477	.9101	.565	.5949	.0005	.178	.5134	.9143	.475
.5508	.9161	.478	.5970	.0046	.183	.5195	.9260	.340
.5550	.9241	.360	.6011	.0124	.185	.5224	.9315	.275
.5569	.9277	.303	.6036	.0172	.173	.5285	.9432	.218
.5611	.9358	.233	.6078	.0252	.185	.5329	.9516	+.153
.5632	.9398	.200	.6118	.0329	.153	.5412	.9675	-.001
.5673	.9477	.173	.6150	.0390	-.113	.5530	.9901	.165
.5696	.9521	.148				.5599	.0033	.178
.5738	.9601	.078	718.4799	.8501	+.860	.5632	.0097	.170
.5761	.9645	+.048	.4874	.8645	.875	.5702	.0231	.160
.5804	.9728	-.040	.4909	.8712	.815	.5737	.0298	.148
.5824	.9766	.060	.4992	.8871	.768	.5799	.0417	-.120
.5873	.9860	-.113	.5030	.8944	+.688			
			in blue					
707.5468	.9084	-.010	707.5939	.9986	-.938	718.5084	.9047	+.048
.5490	.9126	.035	.5960	.0026	.958	.5124	.9124	-.095
.5541	.9224	.198	.6001	.0105	.923	.5186	.9242	.255
.5561	.9262	.290	.6022	.0145	.923	.5215	.9298	.353
.5600	.9337	.410	.6067	.0231	.930	.5274	.9411	.460
.5620	.9375	.443	.6089	.0273	.890	.5311	.9482	.520
.5661	.9454	.473	.6126	.0344	.868	.5403	.9658	.720
.5687	.9503	.535	.6188	.0463	-.825	.5519	.9880	.913
.5728	.9582	.608				.5588	.0012	.935
.5750	.9624	.665	718.4809	.8520	+.428	.5621	.0076	.935
.5789	.9699	.740	.4866	.8629	.373	.5690	.0208	.928
.5815	.9749	.800	.4899	.8693	.368	.5728	.0281	.920
.5859	.9833	.888	.4982	.8852	.293	.5789	.0397	-.888
.5888	.9888	-.883	.5019	.8922	+.210			
			in ultraviolet					
718.4857	.8612	-.105	718.5174	.9219	-.780	718.5574	.9986	-1.645
.4887	.8670	.123	.5204	.9277	.915	.5610	.0055	1.650
.4968	.8825	.233	.5259	.9382	1.100	.5677	.0183	1.600
.5005	.8896	.288	.5301	.9463	1.098	.5714	.0254	1.615
.5072	.9024	.433	.5377	.9608	1.248	.5777	.0374	-1.583
.5107	.9091	-.573	.5484	.9813	-1.488			

colour photometer containing an unrefrigerated EMI 6256 photomultiplier tube.

In 1970 during two nights 97 observations of AN Serpentis were obtained, 40 in yellow, 40 in blue and 17 in ultraviolet light. As comparison star we used BD+13°3026(9.5). According to our tie-in observations its brightness and colours are as follows:

$$V = 10.51 \qquad B - V = +0.94 \qquad U - B = +0.64$$

The individual observations in instrumental system are given in Table 3 in the sense variable minus comparison (BD+13°3026). The phases of observations obtained at both the Catania Observatory and the Konkoly Observatory have been calculated by using the formula:

$$\text{phase} = \frac{\text{J.D.} - 2439538.6734}{0.5220729}$$

LIGHT AND COLOUR CURVES

Composite light curve in V is shown in Figure 1. In order to make a more precise analysis of the light and colour curves possible 44 normal points were obtained in V and in both colours which are tabulated in Table 4. Since most of the observations were collected on

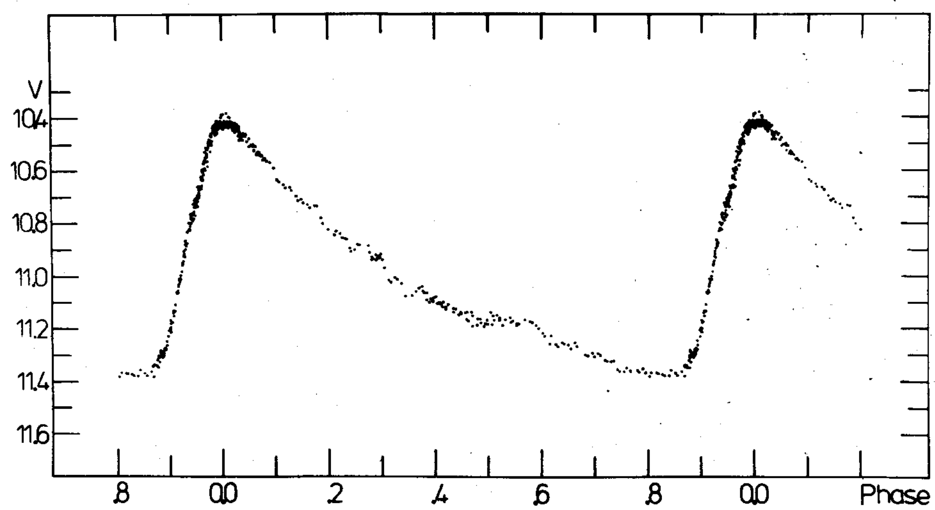

Figure 1. Light curve of AN Serpentis

the ascending branch and near the maxima of the variable, the light curve was not uniformly covered, Therefore, the normal points are not chosen at equal intervals but rather as determined by groups of yellow observations of equal number. Each normal point was formed from nine yellow observations and the colours belonging to these yellow observations. The normal points are plotted against phase in Figure 2. The light and colour curves are very regular and typical of the class of variables which AN Serpentis belongs to.

Figure 3 shows the observations at Catania Observatory plotted against phase.

Both Figure 1 and Figure 3 clearly indicate that no irregularities or non-repetitive behaviour as reported by BATYREV (1957) could

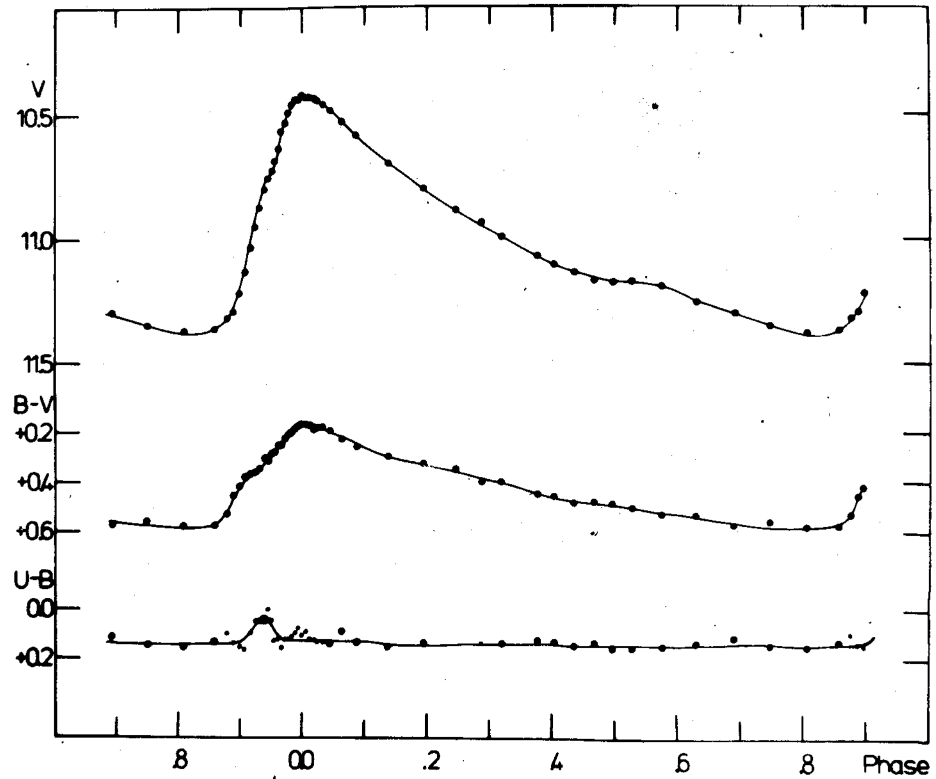

Figure 2. Normal points as function of phase

be detected during the time interval covered by our observations. Nevertheless, it is possible that the star might have had Blazhko-effect and then it disappeared. At present there is no doubt about the stable character of AN Serpentis.

The hump on the ascending branch of AN Ser is conspicuous in both Figure 2 and Figure 3. The duration of the hump fits well into the relation found by DETRE (1959) between the duration of the hump and the visual light amplitude of different RR Lyrae stars.

SPINRAD (1959) observed an unusual hump on the declining branch of the variable. BASU (1968), however, showed that the suspected hump was unreal. Our light curves also confirm BASU's result, there is no unusual hump on the declining branch of AN Serpentis in the phase region $0\overset{P}{.}20 < \phi > 0\overset{P}{.}40$

The two-colour diagram of AN Serpentis is shown in Figure 4. The dashed line represents the main sequence. The phases of AN Ser are shown as numbers on the loop, with zero phase being that of maximum in

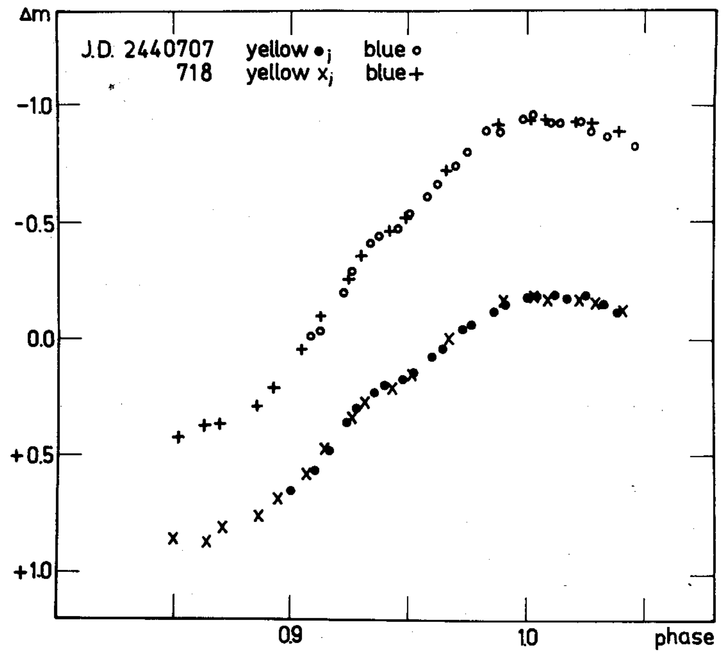

Figure 3. Observations obtained at the Catania Observatory

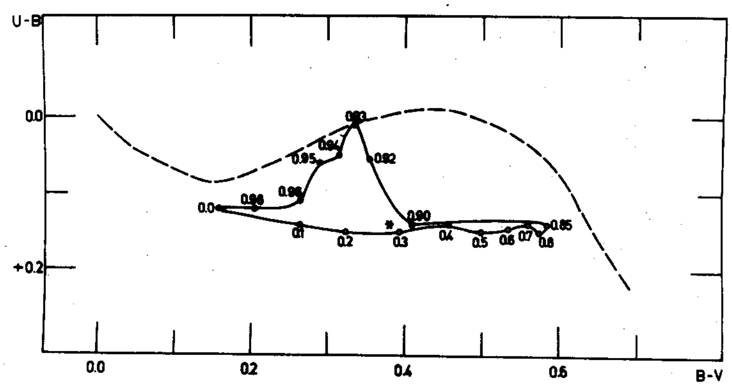

Figure 4. Two-colour diagram for AN Serpentis. Phases are shown as numbers on the loop, with zero phase being that of maximum light.

Table 4

Normal points

Phase	ΔV	n	Δ (B-V)	n	Δ (U-B)	n
$0^{p}.0054$	-0.236	9	-0.463	9	-0.077	2
.0113	.236	9	.455	9	.043	2
.0189	.232	9	.438	9	.041	2
.0245	.222	9	.448	9	.033	2
.0325	.204	9	.450	7	.035	2
.0436	.181	9	.438	9	.028	5
.0634	.138	9	.399	9	.080	6
.0870	-0.081	9	.371	9	.033	8
.1377	+0.032	9	.331	9	.017	9
.1940	.133	9	.306	9	-0.032	6
.2459	.219	9	.284	7		0
.2871	.270	9	.231	9	-0.031	2
.3196	.330	9	.236	8	.027	6
.3768	.408	9	.178	9	.044	9
.4044	.439	9	.173	9	.034	8
.4358	.472	9	.147	9	.020	9
.4683	.503	9	.149	9	.033	9
.4975	.513	9	.143	9	.011	9
.5290	.510	9	.125	9	.014	8
.5758	.528	9	.097	9	.019	9
.6315	.597	9	.094	9	.029	5
.6922	.636	9	.054	9	.054	9
.7486	.690	9	.069	9	.022	9
.8076	.711	9	.050	9	.015	9
.8585	.703	9	.055	9	.038	6
.8784	.657	9	.100	9	.072	3
.8883	.633	9	.175	9	.030	3
.8985	.557	9	.209	9	.016	3
.9075	.470	9	.251	9	.005	2
.9163	.371	9	.260	9	.071	3
.9238	.290	9	.267	9	.117	2
.9306	.211	9	.279	9	.117	2
.9388	.139	9	.326	9	.118	4
.9455	.092	9	.313	9	.166	1
.9506	.062	9	.340	9	.118	2
.9553	+0.022	9	.347	9	.039	1
.9612	-0.030	9	.377	9	.045	3
.9665	.095	9	.373	9	.012	1
.9721	.131	9	.403	9	.042	2
.9767	.172	9	.419	9	.048	2
.9831	.204	9	.429	9	.056	2
.9881	.226	9	.445	9	.070	2
.9930	.225	9	.457	9	.091	1
0.9985	-0.247	9	-0.461	8	-0.063	3

V light. The loop for the variable lies below the luminosity class V line at all phases. This depression of the loop below the main sequence has already been noted by SPINRAD (1959) who attributes the effect to absorption-line blanketing in the ultraviolet as the high galactic latitude of the variable ($b^{II} = 45\overset{\circ}{.}2$) makes any large amount of interstellar reddening very unlikely.

Table 5 summarizes the most important photometric data for AN Serpentis.

Table 5

	V	B	U	B - V	U - B
maximum	10.42	10.57	10.69	+0.15	+0.12
mean	10.97	11.35	11.49	+0.38	+0.14
minimum	11.38	11.97	12.11	+0.59	+0.14
amplitude	0.96	1.40	1.42	0.44	-

The mean values of the colour indices are $\langle B - V \rangle = +0.41$ and $\langle U - B \rangle = +0.14$, while PRESTON's quantities for the U - B excess on the rising branch: $\delta_1 = 0.13$ and $\delta_2 = 0.13$. The interval between minimum and maximum, divided by the period is $\varepsilon = 0\overset{P}{.}16$, while the time from hump to maximum expressed in period is $\varepsilon^* = 0\overset{P}{.}06$.

PERIOD CHANGES AND O - C DIAGRAM

All the maxima published and known to us are listed in Table 6. In addition to the reference where the maxima observed were published we denoted the kind of observations: vis=visual, pg=photographic, and pe=photoelectric.

The O - C values have been calculated by using the formula:

$$C = \text{J.D. } 2414708.9500 + 0\overset{d}{.}52207162 \cdot E$$

Having scrutinized our photoelectric blue and yellow light curves we have not found any measurable phase leg between them. Therefore we have not applied any corrections to the visual or photographic maxima.

For all the photoelectric observations do not exhibit any sign of light curve variation we have formed a mean value of O - C's for each year. These average O - C values are plotted against Julian Days in Figure 5. If we do not question the very uncertain observation at J.D.2426122 we can conclude from the O - C diagram that the period of AN Serpentis decreased by 0.00001 day around J.D.2428000. A slight increase of the period might take place in the last 20 years.

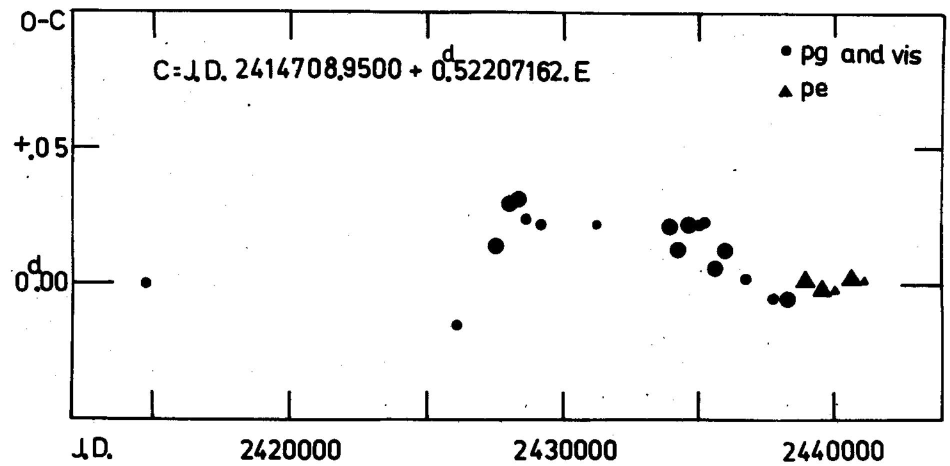

Figure 5. O - C diagram for AN Serpentis

Table 6

Year	J.D.24...	Reference		O - C	E	$\overline{O - C}$	$\overline{E}$
1899	14708.950	Payne-G. (1954)	pg	.0000	0	.0000	0
1930	26122.464	Soloviev (1936a)	"	-.0158	21862	-.0158	21862
1934	27462.673	v.Schewick (1942)	"	+.0354	24429	+.0141	24580
	463.686	"	"	+.0043	24431		(6)
	521.635	"	"	+.0033	24542		
	543.546	"	"	-.0127	24584		
	599.461	"	"	+.0406	24691		
	657.384	"	"	+.0137	24802		
1935	874.620	"	"	+.0679	25218	+.0294	25471
	931.487	"	"	+.0291	25327		(13)
	953.453	"	"	+.0681	25369		
	955.488	"	"	+.0148	25373		
	28007.193	Soloviev (1935)	v"s	+.0347	25472		
	010.311	Soloviev (1936a)	"	+.0203	25478		
	011.346	"	"	+.0111	25480		
	021.266	"	"	+.0118	25499		
	033.263	"	"	+.0011	25522		
	043.208	"	"	+.0268	25541		
	045.337	v.Schewick (1942)	pg	+.0675	25545		
	046.331	"	"	+.0173	25547		
	155.438	Soloviev (1936b)	vis	+.0114	25756		
1936	219.688	v.Schewick (1942)	pg	+.0465	25879	+.0309	26095
	245.265	Soloviev (1936a)	vis	+.0420	25928		(12)
	256.227	"	"	+.0505	25949		
	280.219	"	"	+.0172	25995		
	308.430	v.Schewick (1942)	"	+.0364	26049		
	332.444:	"	"	+.0351	26095		
	333.472	"	"	+.0189	26097		
	369.513	"	"	+.0370	26166		
	391.433	"	"	+.0300	26208		
	403.423:	"	"	+.0123	26231		

Table 6 (continued)

Year	J.D.24...	Reference		O - C	E	$\overline{O-C}$	$\overline{E}$
1936	28424.326	v.Schewick (1942)	vis	+.0325	26271		
	425.360	"	"	+.0223	26273		
1937	609.131	Soloviev (1940b)	"	+.0241	26625	+.0241	26625
1938	29156.260	Soloviev (1940a)	"	+.0221	27673	+.0221	27673
1944	31235.149	Tsessevich (1966)	"	+.0219	31655	+.0219	31655
1951	33876.303	Batyrev (1957)	"	+.0155	36714	+.0209	36750
	886.233	"	"	+.0262	36733		(7)
	887.271	"	"	+.0200	36735		
	898.235	"	"	+.0205	36756		
	899.283	"	"	+.0244	36758		
	909.202	"	"	+.0240	36777		
	910.238	"	"	+.0159	36779		
1952	34128.466	"	"	+.0180	37197	+.0131	37316
	149.344	"	"	+.0131	37237		(6)
	174.410	"	"	+.0196	37285		
	184.331	"	"	+.0213	37304		
	242.265	"	"	+.0053	37415		
	265.232	"	"	+.0012	37459		
1953	515.341	"	"	+.0379	37938	+.0214	38051
	540.403	Alanija (1954)	pg	+.0404	37986		(5)
	562.305	Batyrev (1957)	vis	+.0154	38028		
	621.288	"	"	+.0043	38141		
	632.256	"	"	+.0088	38162		
1954	986.234	"	"	+.0223	38840	+.0223	38840
1955	35248.312	"	"	+.0203	39342	+.0225	39367
	274.420	"	"	+.0247	39392		(2)
1956	606.445	Batyrev (1964)	"	+.0122	40028	+.0060	40065
	628.359	"	"	-.0008	40070		(4)
	629.397	"	"	-.0070	40072		
	639.343	"	"	+.0197	40091		
1957	928.552	"	"	+.0010	40645	+.0126	40745
	993.339	"	"	+.0511	40769		(4)
	995.373	"	"	-.0032	40773		
	36005.297	"	"	+.0015	40792		
1959	660.497	Tsessevich (1966)	pg	+.0016	42047	+.0016	42047
1962	37817.400	"	"	-.0061	44263	-.0061	44263
1963	38205.308	"	vis	+.0027	45006	-.0055	45068
	229.314	"	"	-.0066	45052		(4)
	252.281	"	"	-.0108	45096		
	264.292	"	"	-.0074	45119		
1965	845.891	Fitch et al. (1966)	pe	+.0038	46233	+.0015	46336
	846.933	"	"	+.0016	46235		(3)
	39006.6845	Basu (1968)	"	-.0008	46541		
1967	537.631:	present paper	"	-.0011	47558	-.0022	47601
	538.6745	"	"	-.0017	47560		(5)
	547.5485	"	"	-.0030	47577		
	560.601	"	"	-.0023	47602		
	617.5060	"	"	-.0031	47711		
1968	996.5310	"	"	-.0021	48437	-.0021	48437
1970	40707.5971	"	"	+.0025	49799	+.0022	49810
	718.5600	"	"	+.0019	49820		(2)
1971	41117.4220	"	"	+.0012	50584	+.0012	50584

We are indebted to Prof. L. DETRE for drawing our attention to this star and for useful discussions. One of us (S.K.) is grateful to Prof. G. GODOLI for providing opportunity to observe this star at the Catania Observatory. Our thanks are also due to Miss A. FARÁDI and Mrs. I. KÁLMÁN for preparing the manuscript.

REFERENCES

Alanija, I.F., 1954, Astron.Circ. 146. 14

Basu, B., 1968, Publ. Astr. Soc. Pacific 80. 612

Batyrev, A.A., 1957, Peremennye Zvezdy 12. 137

1964, Peremennye Zvezdy 15. 278

Detre, L., 1959, Kleine Veröff. Bamberg Nr.27, p.23

Fitch, W.S., Wisniewski, W.Z. and Johnson, H.L., 1966, Commun. Lunar and Planetary Laboratory No.71, Vol.5, Part 2

Gaposchkin, S., 1952, Harvard Ann. 115. 257

Hoffmeister, C., 1935, Astron. Nachr. 255. 401

Joy, A.H., 1950, Publ. Astr. Soc. Pacific 62. 60

Payne-Gaposchkin, C., 1954, Harvard Ann. 113, 153

Prager, R., 1941, Harvard Ann. 111

Preston, G.W., 1959, Astrophys. J. 130. 507

van Schewick, H., 1942, Astron. Nachr. 272, 197

Soloviev, A.V., 1935, Tadjik Observatory Circular No.10

1936a, Tadjik Observatory Circular No.19

1936b, Tadjik Observatory Circular No.20

1940a, Tadjik Observatory Circular No.43

1940b, Peremennye Zvezdy 5. 313

Spinrad, H., 1959, Publ. Astr. Soc. Pacific 71. 542

Struch, C., 1966, Astrophys. J. 143. 774

Szeidl, B., 1968, IBVS No.291

Tsessevich, V.P., 1966, RR Lyrae-Type Variable Stars (Press "Naukova-Dumka" Kiev, in Russian) p. 118